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By Order of the Trustees,

E. RAY LANKESTER,

Director.

24 APR 1908

GUIDE
TO THE
GALLERY OF FISHES

IN THE
DEPARTMENT OF ZOOLOGY
OF THE
BRITISH MUSEUM (NATURAL HISTORY),
CROMWELL ROAD, LONDON, S.W.



ILLUSTRATED BY 96 FIGURES.

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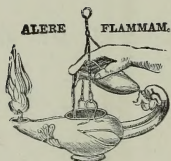
[W. G. Ridewood.] *x ref.*
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PREFACE.

THE arrangement of the Fish Gallery and the preparation of the coloured skins and casts which are there displayed, have occupied a good deal of my time for the last four years. The work of mounting and labelling have been done under my supervision by Dr. Ridewood; the preparation of coloured skins and casts by the taxidermists and modellers employed for the purpose.

If large series of fishes are to be exhibited to the public, it seems to be necessary that they should be carefully painted over so as to give, as far as possible, the natural colours of fresh specimens. This is an extremely difficult task and I have no doubt that, in spite of the care which has been taken, correction and revision will be needful hereafter, in regard to some of the specimens. Many of the specimens have been coloured from life and the rest from authoritative coloured drawings either published or communicated for the purpose.

The models of Deep-sea Fishes and of several extinct fishes have been most carefully executed under my constant supervision and are entirely new. The series of the species of living Dipneusta (*Prtoopterus* and *Lepidosiren*) are admirable representations of those fishes. The specimens of the Tunny, of the Flying Gurnards, and of the brilliantly

coloured Plectognaths, Angel-fish, and similar forms seem to justify the method of coloration employed. The principle had already been accepted by the late Keeper of Zoology, Dr. Günther, who had prepared several specimens coloured in this way. I believe that there is no other collection of Fishes in a public museum in which the specimens are presented without the usual iron supports, with sufficient space around each fish and in natural colours, instead of the oily brown which all dried fish skins tend to acquire.

The attitude of the specimens in the Gallery is *either* that of a dead specimen lying on a slab, *or* is a conventional one chosen so as to shew as much of the character of the fins as possible. It would not be possible to faithfully present the fish in the act of swimming, nor would fish in their natural surroundings be a desirable kind of exhibit: for, like many other animals, fish in their native haunts are usually concealed by their colour and surroundings from the observer's eye.

The present Guide has been prepared by Dr. Ridewood in daily consultation with me. Several of the illustrations are new: for others we are indebted to Guides formerly published by the Trustees, and to Messrs. Macmillan and Messrs. A. and C. Black.

Every specimen in the Gallery is provided with a number and is referred to in this Guide by that number printed in thick large type.

The English names or common names of specially interesting fishes are affixed in large letters to the glass of the case in a position near the specimens of such fishes.

All those fishes which come under the head of British Food-fishes are indicated in the case by the letters B. F. F.

The label of each specimen gives its zoological name, its local name, its English name or names, and as far as practicable its French, German and Italian names. The distribution of

the species is stated and the particular locality from which the specimen exhibited was obtained. In addition information is given as to any matters of special interest concerning the fish. This Guide is a collection of the labels with some additions, arranged systematically so as to shew the groups into which fishes are divided, and is illustrated by figures which are to a large extent taken from photographs of the specimens actually seen in the cases.

E. RAY LANKESTER,

Director.

British Museum (Natural History),
London, S.W.

Dec. 23, 1907.

ADDENDUM.

Since the above preface was written, it has been thought desirable not to use the "thick large type" for the numerals denoting the individual specimens, and these have therefore been printed in ordinary type.

THE FISH GALLERY.

INTRODUCTION.

THE Fish Gallery is on the main floor of the Museum, in the western portion. Visitors entering the Museum can reach the Fish Gallery by turning sharply to the left into the Bird Gallery, and taking the first turning to the right ; or by passing through the Entrance Hall along the left side, and, on reaching the archway at the left side of the main staircase, turning to the left through a small doorway.

The specimens exhibited in the Fish Gallery consist mainly of stuffed specimens, coloured as far as possible to resemble the fishes in their natural conditions ; there are also some casts and models of fishes, the skins of which are not suitable for exhibition, either because of their damaged or distorted condition, or because of their small size, or because the skin is so thin that it cannot be stuffed, or because the fishes are extinct, and only fossil fragments remain to indicate to us what they must have looked like.

Only a small proportion of the Fishes in the Museum are exhibited in the Fish Gallery ; the greater number are preserved in alcohol and, as a precaution against fire, are stored in a detached building at the back of the Museum. These specimens are mostly unsuited for exhibition, and are not accessible to the general public ; they are, however, available for scientific purposes by ichthyologists under certain conditions, which can be ascertained by making application in writing to the Museum. A large

Exhibited
specimens.

Specimens
for
Study.

collection of skeletons of Fishes is similarly available for purposes of scientific study.

On entering the Fish Gallery from the Bird Gallery the visitor will see two small Table-cases (21 and 22) standing in the middle line of the Gallery, the first containing specimens and enlarged models of the Lancelet, and the second containing Lampreys and Hag-fishes. These are not "Fishes" in the strict use of the word. The Lancelet is not even a vertebrate animal, in the sense in which that term is now employed, but belongs to the Cephalochorda, a division of the Chordata ranking equal with the Urochorda or Tunicates (Sea-squirts, Salps, &c., exhibited in the Shell Gallery), and the Vertebrata (including Lampreys, Fishes, Amphibians, Reptiles, Birds and Mammals). The Lancelet resembles the Tunicates and the Vertebrates in having a median skeletal rod, known as the notochord, in the dorsal position and tubular character of the central nervous system, and in the perforation of the side wall of the body in the neck region by gill-slits. The Lancelet differs from the Tunicates and Vertebrates in that the notochord extends farther forward than the central nervous system.

CEPHALOCHORDA (Lancelet).

Table-
case 21.

The Lancelet or *Amphioxus* (fig. 1) is a small, semitransparent, marine animal about two inches in length (see specimens in alcohol, 1046, Table-case 21); it lives in shallow seas in many parts of the world and frequently buries itself in the sand. The edge of the mouth is produced into a number of curved bars or "buccal cirri" (see enlarged model, 1047), which act as strainers and prevent sand grains from getting into the mouth, while not stopping the water that is used for respiratory purposes, nor the minute living organisms that constitute the food of the Lancelet. The gill-slits do not open directly on to the exterior of the body, but are covered in by a wall called the atrial wall, which extends as far back as the pore (atriopore), through which issues the water that has passed through the gill-slits. The anus or vent is unsymmetrical, being set on the left side of the lower fin; there is no distinct head, no paired fins, and no paired eyes or ears.

For the general internal structure of the Lancelet the visitor is referred to the special case affixed to the side of one of the arches on the West side of the Entrance Hall of the Museum.

The two specimens A and B, 1048, mounted on the framed pane of glass in Table-case 21 are wax models, enlarged 100 diameters, showing the remarkable lack of symmetry that exists during the early or larval stages of the Lancelet. The mouth develops on the left side, and only subsequently passes downward to occupy a median position. Primary gill-slits, to the number of fourteen, appear in the ventral median line and move upwards on the right side. Eight secondary gill-slits then appear above them on the right side, and, as they enlarge, the primary gill-slits descend and pass across to occupy their permanent position on the left side. After this, tertiary gill-slits develop on both sides behind the existing ones and continue to increase in number throughout life. The

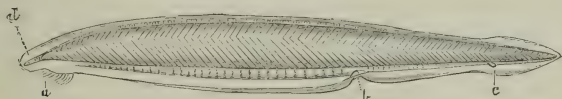


FIG. 1.—Lancelet: *a*, mouth; *b*, atriopore; *c*, vent or anus; *d*, anterior end of notochord.

three models 1049 C, D, and E on the other framed glass show the manner in which the atrial wall, which in the adult covers over the gills, closes by the downward and horizontal extension of the side folds of the body (metapleural folds), and the union of the edges of these flaps along the middle. The models represent three different stages of development, and show the ventral or under surface of the larva. In C there is no atrial floor, the right and left metapleural folds being distinct; in D the horizontal ledges growing in from the inner faces of the metapleural folds have united in the hinder part; in E the whole of the atrial floor is complete except at the extreme anterior end.

On the other side of the Table-case are shown enlarged models of Tunicates for comparison with the Lancelet, one (1050) of the larva of a simple Ascidian such as the common Sea-squirt, and three models (1051, 1052, 1053) showing different views of an

adult Appendicularia (*Fritillaria furcata*), which is one of the few Tunicates that retain the tail in adult life.

At the end of the case are shown drawings of ten species of the Lancelet.

CYCLOSTOMI (Lampreys and Hag-fishes).

Table-
case 22.

The Cyclostomi, or Lampreys and Hag-fishes, are aquatic Vertebrates not included among the "Fishes" or Pisces because of the absence of a hinged lower jaw. The mouth is adapted for sucking; when open it is round in shape (whence the name Cyclostomi, or "round-mouth"), and it is closed by the approximation of the right and left margins; the teeth are of a horny material and have a vertical succession. The body is long, without scales in the skin; the tail-fin is simple, and there are no paired fins and no traces of pectoral and pelvic girdles. The nostril is single; the gills are in pouches, the external and internal openings of which are small. The skeleton is fibro-cartilaginous, and the notochord persists for life. Two divisions of the Cyclostomi are recognised, the Hyperoartia (Lampreys) and the Hyperotreta (Hag-fishes).

In the Hyperoartia the external nasal aperture is on the upper surface of the head, and from the inner end of the nasal sac there leads back a tube which ends blindly above the pharynx (see dissection 1059). There are no barbels. The eggs are small (see 1060). Each gill-pouch has its own external aperture. The median fins are relatively larger, and are more subdivided than in the Hyperotreta. Various species of the Lamprey occur in the temperate parts of the northern hemisphere, the commonest being the Lamprey, *Petromyzon marinus*, 1057, and the Lampern or River Lamprey, *Petromyzon fluviatilis*, 1058.

Lamprey.

The word Lamprey comes to us from the Low Latin name *lampreda* or *lampetra*, the licker or sucker of rocks, applied to the animal on account of its peculiar habit of adhering by its mouth to stones. The generic name *Petromyzon* applied by scientists refers also to this habit. The mouth when open (1062) forms a sucking disc, with numerous brown, horny teeth arranged in circular and radiating rows, and with some in the centre

supported by the tongue. The circular lip around this sucking disc is fringed with numerous short tentacles. The Lamprey does not "bite" its food as an animal with ordinary jaws would do, but attaches itself by its disc to the skin of living Cod, Haddock, and Mackerel, and gnaws away the flesh by its pointed conical teeth, until it has satisfied its hunger, when it leaves the fish to recover, or more probably to die.

The Lamprey has two dorsal fins, the second being continuous with the caudal; the skin is slimy, the eyes are very small and situated in front of the seven small, circular gill-openings. The skull of the Lamprey affords but little protection to the upper part of the brain, the roof consisting merely of a narrow "occipital arch" (see 1061). The "subocular arch" possibly corresponds with the palato-quadrate cartilage of the true Fishes, the cartilage which in Sharks and Lung-fishes functions as the upper jaw and bears the upper teeth.

Lampreys ascend the rivers from the sea in the spring to deposit their spawn. They grow to 30 inches in length and 3 lbs. in weight. They were esteemed a delicacy in olden times, but they are not much eaten at the present day; they are, nevertheless, wholesome food, and the historical incident firmly fixed in the memory of most schoolboys, that Henry I. died after a surfeit of Lampreys, should not be allowed to tell against them as an article of diet. In England the principal Lamprey fishery is in the Severn.

The Lampern, *Petromyzon fluviatilis*, 1058, bears a general Lampern. resemblance to the Lamprey, but it rarely attains a greater length than 16 inches, at all events in British rivers. It usually spends the whole of its life in fresh water, although some individuals have been caught in the sea. Its skin is not mottled as is that of the Lamprey, and the eye is relatively larger. The Lampern does not seem to prey upon living fish as does the Lamprey. It makes excellent bait for Cod and Turbot.

Planer's Lamprey, *Petromyzon planeri*, is smaller than the Lampern, and differs slightly in the arrangement of the teeth, the shape of the dorsal fin, and in its habit of living in the mud, whence it is sometimes called the Mud-Lamprey. The larval forms of the Lampern and Planer's Lamprey are known as

"Ammocæte" (1063), or more popularly as Pride or Sand-piper. The Ammocæte differs from the adult in having no tongue or teeth, in possessing a hood-like anterior lip instead of an oral sucker, in the large size of the internal or pharyngeal apertures of the gill-pouches, and in the fact that the respiratory part of the pharynx is not shut off by a horizontal partition from the food channel.

In South America and Australia the Lampreys are represented by the genera *Mordacia* and *Geotria* (1064).

In the Hyperotreta the external nasal aperture is situated at the extremity of the snout, and from the inner end of the nasal sac there leads back a tube which opens into the roof of the pharynx (see dissection 1066). There are barbels on the snout. The skin is capable of secreting enormous quantities of glutinous slime. The eggs are large (see 1068). In *Bdellostoma* (1067) each gill-pouch has its own aperture on the side of the body, but in the Hag-fish, *Myxine*, 1065, exhalent tubes from the pouches lead back and open together. *Bdellostoma* occurs plentifully in the bays along the Pacific coast of America; *Myxine* is found widely distributed in the temperate zones of the northern and southern hemispheres. Both feed on fish, and *Myxine* not infrequently bores its way into the abdominal cavity of the Cod.

Hag-fish.

PISCES (Fishes).

The Lancelet and Lampreys having been disposed of, there remain for consideration the true Fishes or Pisces, a class of the Vertebrata ranking equal with the Amphibia (Frogs and Newts), Reptilia (Turtles, Crocodiles, Lizards, Snakes), Aves (Birds), and Mammalia (Mammals, *e. g.* Rabbit, Dog, Horse, Man).

Fishes are Vertebrate animals with a distinct and hinged lower jaw, passing their whole life in water (with a few exceptions), and possessing common distinctive characters in those systems of their organization which are in direct relation to their aquatic mode of life, namely, in the organs of respiration and locomotion. The respiratory organs are gills, groups of delicate vascular filaments

projecting from the front and hind walls of the gill-slits, and supported by skeletal bars called branchial arches. An air-bladder is frequently present and serves as a hydrostatic organ or float, while in a few cases it may act as a lung and help the gills in their work of respiration. The organs of smell are paired, and only in rare cases (Lung-fishes) communicate with the mouth-cavity by internal nostrils. Except in the Lung-fishes the heart has but one auricle and receives only venous blood, which it forces, first through the blood-vessels of the gills and thence as arterial blood through the vessels of the body generally. The skin is either soft and bare or is hardened by the development of spines or denticles, or overlapping scales, or bony plates (scutes). Peculiar cutaneous sense-organs are distributed along the sides of the body (lateral line organs) and on the head, and appear to be specially associated with an aquatic mode of life. Such organs only occur elsewhere in Amphibians; in the tailless Amphibians (Frogs and Toads) they exist only in the larval or tadpole stages (except in the Cape-toad, *Xenopus*). The principal organ of locomotion is the powerful muscular tail; this is assisted by the pectoral and pelvic limbs, paired fins corresponding with the fore and hind limbs of terrestrial Vertebrates. The skeleton of these paired fins cannot readily be compared with the limb-skeleton of other Vertebrates, there being no such bones as humerus, radius, carpal and phalangeal bones, and the edge of the fin is not divided into the five toes, which are, with exceptions, so regularly present in all other Vertebrates. Fishes also possess median fins on the back (dorsal fins) and between the anus and tail (anal fin); these fins are supported by skeletal bars or rays, whereas in Newts and other Vertebrates with median fins there are no skeletal structures in those fins.

The scheme of classification adopted in the arrangement of the Fish Gallery is set out on pages 200–201. The systematic series of Fishes is exhibited in the Wall-cases, commencing with Wall-case 1 (Sharks and Dog-fishes) in the S.W. corner of the Gallery, and ending with Wall-case 20 (Angler-fishes, File-fishes, Globe-fishes, and Sun-fishes) in the S.E. corner. Standing on the floor of the Gallery or suspended from the roof are other

specimens, either too large to exhibit in the Wall-cases, or else constituting series of special interest, such as Deep-sea Fishes, Eggs and Young of Fishes, &c.

CENTRAL EXHIBITS.

The Table-cases 21 and 22, containing specimens of the Lancelet and of Lampreys and Hag-fishes, encountered by the visitor on entering from the Bird Gallery, have already been alluded to (pp. 2-6). In the same line is a third Table-case (23) containing a Port Jackson Shark, *Cestracion philippi*, four feet long, caught in Sydney Harbour in 1906.

Basking
Shark.

In the middle of this half of the Gallery, surrounded by a mahogany rail, is the cast of a skeleton of the Basking Shark, *Selache maxima* or *Cetorhinus maximus*, which was caught off Bergen, in Norway, in May 1901, and measured $28\frac{1}{2}$ feet. The

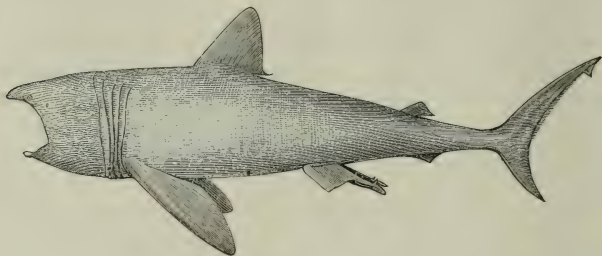


FIG. 2.—Basking Shark, *Selache maxima*.

principal features of the skeleton of Sharks may be studied by reference to this specimen. The great jaws are connected with the cranium by the upper piece of the hyoid arch called the hyomandibular cartilage—a skull in which the jaws are so suspended is called “hyostylic” (compare the “amphistylic” skull of *Notidanus* (Wall-case 1) and the “autostylic” skull of the Holocephali (Wall-case 5), and Dipnoi. The characters of the gill-arches and gill-rays are well shown in this specimen, as also

are the features of the vertebral column, the pectoral and pelvic girdles, and the skeletal parts of the pectoral, pelvic, dorsal, anal and caudal fins, except that the horny fin-rays are not reproduced in the cast. For an illustration of horny fin-rays the visitor is referred to the skeleton of the pectoral fin of the Dog-fish (3) in Wall-case 1.

Hanging from the roof above the skeleton is a specimen of the Basking Shark, 28 feet long, caught off Bergen in 1904, and presented to the Museum by the Hon. Walter Rothschild. The Basking Shark grows to 33 feet or more. Its food consists of small fishes and other marine animals that swim in shoals. The gill-rakers are highly specialised, and serve to retain the smallest food organisms and to prevent their escaping through the gill-slits. On the west coast of Ireland the Basking Shark is caught for the sake of the oil obtained from the liver. The Shark is of a harmless disposition and does not attack man.

On the left side of the skeleton is the head of a Basking Shark which was 28 feet long, and was caught in March 1875 near Shanklin, in the Isle of Wight*. This head shows the great size of the gill-slits, the right and left of which nearly meet under the throat, and the smallness of the teeth. On the other side of the skeleton are the pelvic fins of the same specimen, which was a male. The males of all Sharks have the pelvic fins produced backward into "claspers," and the interest of the present specimen lies in the fact that the tooth-like bodies on the claspers of the Basking Shark were first known in the fossil state, and their true nature was only recognised when the Shanklin specimen was exhibited in the year 1876. Three examples of fossil clasper-spines are exhibited in the box adjoining. These are from the Red Crag of Suffolk; similar specimens have been obtained from the Crag of Antwerp. Such spines were long a puzzle to palæontologists, by whom they were regarded as the terminal phalanges of some large Reptile or Mammal, or the separated lamellæ of young teeth of a Mastodon or Mammoth, or the central cores of teeth of a Xiphioid Whale.

* Figure 2 was drawn from this specimen.

Rays. On the floor within the same railing are specimens of an Electric Ray, *Torpedo hebetans*, 1080, caught in the Menai Straits, North Wales, and a large Ray, *Raia marginata*, 1079, caught in Walfish Bay, South-west Africa.

Hanging from the roof in the middle of the Gallery are two other large Rays, both from Muscat, in Arabia—an Eagle-Ray, *Aëtobatis narinari*, and a Devil-Ray, *Dicerobatis eregoodoo*, a fish which grows to 15 feet in width, and is distinguished by the paired projection (head-fins) in front of the mouth.

Beyond these Rays, also hanging from the roof, is a Whale Shark, *Rhinodon typicus*, the largest of all Sharks, growing to 50 or 60 feet in length; the specimen shown is not more than half the full size. The Whale Shark occurs mostly in the Indian and Pacific Oceans and has been caught off Florida and the Cape of Good Hope. Like the Basking Shark the Whale Shark is a slow-moving, apathetic fish, harmless to man, and often found basking or sleeping at the surface of the sea. The mouth and nasal openings are near the extremity of the broad, flat snout. The dorsal fin is much farther back than is that of the Basking Shark, and the gill-slits are not so large. The teeth are extremely small for so large an animal (see specimen 53 in Wall-case 1), and are closely set in regular rows in the form of a ribbon. The Whale Shark feeds on the minute semitransparent crustaceans and molluscs that abound at the surface of the sea, and to a certain extent also on sea-weed.

Hanging from the roof at the North end of the Gallery is a large specimen of the Sun-fish, *Orthogoriscus mola*, from Australia, and hanging near it is a smaller specimen of the same species caught off Dungeness in Kent (see fig. 3).

Side-rails. Running the whole length of the Gallery are two side-rails suspended from the roof by chains. Hanging from these rails are, besides the Sun-fish just mentioned, a Sturgeon* (opposite Wall-cases 6 and 7), 10 feet 4 inches long, caught off the Dogger

* For information concerning the structure and habits of these suspended fishes the visitor is referred to the accounts given in the description of the Systematic Series of Fishes exhibited in the Wall-cases.

Bank in 1873; a Saw-fish, *Pristis pectinatus* (in front of Wall-case 5) from Trinidad; a Greenland Shark, *Læmargus borealis* (in front of Wall-cases 3 and 4), 15 feet long, caught on the East coast of Scotland in 1878; a Thresher or Fox Shark, *Alopias*

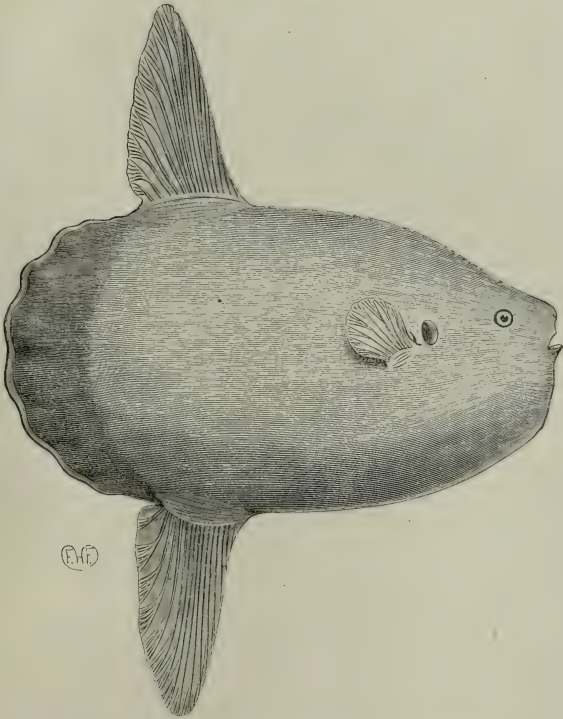


FIG. 3.—Rough Sunfish, *Orthogoriscus mola*.

vulpes (opposite Wall-case 3), caught on the Devon coast in 1897; a Shark of the Indian Ocean, *Ginglymostoma cirrhatum*; and a Grey Shark, *Notidanus griseus* (opposite Wall-case 1) from the Orkney Isles.

On the other rail are an *Odontaspis americanus* (opposite Wall-case 20); an Elfin Shark, *Mitsukurina owstoni*, caught in 300 fathoms off Japan in 1903; an Indian Shark, *Carcharias hemiodon*, allied to the Blue Shark and White Shark, which are also species of *Carcharias*; a stuffed specimen and a pair of jaws of a Shark known as *Galeocерdo rayneri*, the teeth of which are curiously marked by a deep notch on the outer edge; a stuffed specimen and a pair of jaws of the Hammer-head Shark, *Zygæna malleus*; and two Sting-Rays, *Trygon brevicaudata*, from New Zealand, and *Trygon tuberculata*, from Australia.

Floor-
case 27.

Near the doorway at the North end of the Gallery and occupying a middle position between Wall-cases 8 and 13, is a Floor-case (27), which, at the time of writing, contains a Tarpon, *Megalops atlanticus*, 1110, seven feet long, presented in 1899 by His Majesty the King, then Prince of Wales; also a large Angler, *Lophius piscatorius*, 1016, and an Opah, *Lampris luna*, 1108, both presented by the Hon. Walter Rothschild; also a skeleton of the Opah, 1109. Close around this Floor-case are five Cabinet-cases (26, 28, 29, 30, 31) the arrangement of which is not at the time of writing sufficiently complete for description. They are intended for series of eggs and young of Fishes, nests and modes of protection of the young, long-bodied eel-like fishes of different families, Electric Fishes, Flying Fishes, Sound-producing fishes, fishes with poisonous flesh, fishes with poison-spines, fishes with suckers, fishes with accessory breathing-organs, hybrids in fishes, differences between male and female fishes, isinglass from Sturgeon and *Polynemus*.

In the vicinity of the Cabinet-cases are three skeletons under glass, standing on separate tables, namely, the Nile Perch, *Lates niloticus* (Table-case 33), from the Fayûm Lake, Egypt, a skeleton 55 inches long; a Parrot-fish, *Pseudoscarus muricatus* (Table-case 32), with the pharyngeal bones separated from the rest of the skeleton to show the curious pavement of pharyngeal teeth; and a Stone Bass or Wreck-fish, *Polyprion cernium* (Table-case 34), of which a stuffed specimen is shown in the left upper part of Wall-case 13.

On the large table between Wall-cases 6 and 15, surrounded by a mahogany rail, are a Great Blue Shark, *Carcharodon rondeletii*, from the Atlantic coast of North America, and, on the other side, a Mackerel Shark, *Lamna spallanzanii*, and the jaws of a Mackerel Shark, and those of a Great Blue Shark much larger than the one shown on this table. On the floor within the railing are a number of specimens, the final positions for which have not at the time of writing been decided; they are a skeleton of the Southern Ribbon-fish, *Regalecus argenteus*, a very fine specimen, 12 feet long; a specimen of *Euxymetopon poeyi*, a fish allied to the Hair-tails (Wall-case 17); a skeleton of the deep-sea fish *Alepidosaurus ferow*, with great teeth and a large dorsal fin supported by unbranched fin-rays; a form of Sea-perch, *Epinephelus cernioides*, not very large considering to what a great size some of the Sea-perches or Jew-fishes attain, but interesting as being a specimen caught off the Cornish coast; a Meagre, *Sciæna aquila*; a Skate, *Raia batis*; a Sturgeon, *Acipenser sturio*; and a Quinnot Salmon, *Onchorhynchus quinnot*, which weighed 70 lbs. when caught.

Great
Blue
Shark.
Table 25.

Standing between the two railed enclosures in the middle line of the Gallery is a Floor-case (24) devoted to the Sword-fishes and Sail-fishes. A description of the contents of this case is given on page 170.

On one side of the Sword-fish case (24) is a small Table-case (37) containing a skeleton of one of the African Siluroids or Cat-fishes, *Arius latiscutatus*, and on the other side a Table (49) with a large Halibut, *Hippoglossus vulgaris*, 6 feet 2 inches long, caught in the North Sea in 1902, and a cast of a very fine *Lepidotus maximus*, from the Lithographic Stone of Bavaria, an extinct fish of the family Semionotidæ (see Wall-case 7).

In front of Wall-cases 6 and 7 stand two Table-cases (50 and 51) with a skeleton and two specimens of the great *Arapaima gigas* of the Amazon and neighbouring rivers, a fish belonging to the family Osteoglossidæ (see Wall-case 7 and page 89). Opposite these cases, in front of Wall-cases 14 and 15, are two Table-cases (36 and 35) containing a large specimen of *Platystoma gigas*, from the Upper Amazons, and a skeleton of an equally large *Bagarius*

yarrellii from the Hugly ; both of these are Cat-fishes or Siluroids (see family Siluridæ, Wall-cases 9 and 10, and page 112).

Tunny.

On the other side of the door-way leading into the Entrance Hall is a large Table-case, 38, standing in front of Wall-case 17, containing a very fine specimen of the Tunny, *Thunnus thynnus* (fig. 4), 8 feet long, caught in the English Channel off Weymouth, and also an Albacore, *Thunnus alalunga* ; these are Scombroid or



FIG. 4.—Tunny, *Thunnus thynnus*.

(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.).

Mackerel-like fishes (see Wall-case 15, and p. 165). Next follow four Table-cases (39, 40, 41, 42), with a Barracuda, *Sphyræna commersonii*, from Mauritius (see Wall-case 11 and p. 136) ; a large Sea-perch, *Epinephelus lanceolatus*, 7 feet 3 inches long, from the Indian Ocean (see family Serranidæ, Wall-case 13 and page 147) ; and a skeleton and a stuffed specimen of the Angler, *Lophius piscatorius* (family Lophiidæ, Wall-case 20, floor ; see also page 193).

British
Salmon-
oid
Fishes.

In Cabinet-case 43, standing in front of Wall-case 20, are shown some Salmonoid Fishes of the British Isles ; at the time of writing the series is very incomplete. Other specimens of Salmonoid Fishes are shown in the series of British Fresh-water Fishes in the North Wall-case of the Pavilion at the West end of the Bird Gallery, and some in Wall-case 7 of this Gallery. The tendency of modern students of fishes is to diminish the number of species to which Salmonoid fishes are relegated, and to regard the colouring of the body as of little account compared with such characters as

the size of the scales, and the number of rows in which they are arranged, the positions of the fins and the number of fin-rays in each, the characters of the teeth and the proportions of the bones of the upper jaw and of the gill cover, these characters being reasonably stable, whereas the colouring is largely dependent on the conditions in which the fishes live. As a rule the fresh-water forms are brown or reddish, and the marine forms bright and silvery, and in the case of migratory forms like the Salmon and Sea Trout the change from the one colour to the other is to be observed in the same individual at different periods of its life. In the non-migratory forms the colours are fairly constant while the fish remains in the same waters, but by transferring to new localities brown forms may become silvery and silvery forms brown.

The relation that obtains between the environmental conditions and the colouring of the fish is expressed by Dr. Günther * in the following terms :—" Trout with intense ocellated spots are generally found in clear rapid rivers and in small open alpine pools ; in the large lakes with pebbly bottom the fish are bright and silvery, and the ocellated spots are mixed with or replaced by X-shaped black spots ; in pools or parts of lakes with muddy or peaty bottom the trout are of a darker colour generally ; and when enclosed in caves or holes they may assume an almost uniform blackish coloration."

The remarkable differences in the colouring of Trout living in neighbouring, but non-communicating, waters is nowhere better exemplified than in Sutherland. Loch Scourie, Loch Crocach, Loch Borlanc and Loch Manse all have their own particular type of Trout (see 995, 997, 996, 994). In deep lakes where food is fairly abundant the Trout grow to a large size, and such fish are called Great Lake Trout, fishes long known as *Salmo ferax*. The specimen of Great Lake Trout, 999, exhibited in the Cabinet-case, is from Windermere.

In Loch Leven the Trout, formerly described as *Salmo levenensis*, are slender and more silvery than most non-migratory Trout, with less yellow along the sides of the abdomen and with spots that are dark and without any scarlet. Examples of a male and a female are shown (991, 992). The Galway Trout, of which a specimen

* "An Introduction to the Study of Fishes," 1880, p. 632.

from Connemara is shown, 993, is the fish described by some authorities as *Salmo gallivensis*; it is a robust fish of estuarine habit. Another Irish Trout is 998, a fish from Lough Arrow in Sligo. The Sea Trout is represented by an 8½ lb. fish caught in the sea at Montrose, a 7 lb. fish caught in the Tay at Perth, and a Smolt from the Tay, caught in May.

If the colouring of the body be disregarded, the British species of *Salmo* may be reduced to three, namely, *Salmo salar*, the Salmon and its varieties, *Salmo trutta*, including all the Trouts, such as Salmon Trout, Bull Trout, Great Lake Trout and Brook Trout, and *Salmo alpinus*, including all the Charrs. At the time of writing the Charr is represented in Cabinet-case 43 by three specimens, from Buttermere, Windermere and Loch Scourie respectively.

Deep-sea
Fishes.

Deep-sea Fishes (see Cabinet-case 44) are not fishes of any particular order, but are fishes of genera belonging to numerous families more or less unrelated which have a deep-sea habit, the other members of the families being surface forms or coast forms. The proportions of the deep-sea genera to the others varies in different families. The families Alepocephalidæ (Wall-case 7), Stomiidæ (Wall-case 7), Scopelidæ (Wall-case 10), Halosauridæ (Wall-case 10), Macruridæ (Wall-case 11), Ceratiidæ (Wall-case 20) consist almost entirely of deep-sea forms, whereas among the Eels (Wall-case 8) and Gadidæ (Wall-case 11) a moderate proportion of the genera occur in deep water, and in the Salmonidæ only a very few, such as the Argentine (295, Wall-case 7).

While the animals that live in shallow seas near the coast—animals such as fishes, crustaceans, molluscs, worms and jelly-fishes—exhibit considerable differences in different parts of the world, this is not the case with the animals which inhabit the deeper parts of the sea. The species of deep-sea fishes and other animals which are at all well known have a wide distribution.

Removed from the glare of the sun, the fishes of the deep seas have become modified in relation with the subdued light in various directions. Most have exceptionally large eyes (e.g. *Aphanopus*, 982, Cabinet-case 44), so as to bring to a focus as much as possible of the faint light that succeeds in penetrating to the great depths; a few have eyes which have undergone so much reduction that the fishes are blind, and rely for the capture of their food upon the

increased acuteness of sense organs other than the eyes ; some again are uniformly phosphorescent or have special luminous organs on the head or in series along the body.

Most are of a pale green or blue colour when caught (see coloured sketches 980 and 981), but they rapidly turn black ; it is for this reason that the coloration of many of the models shown is blackish. Some deep-sea fishes are colourless and gelatinous in appearance (e. g. *Aphyonus*, 974). In those which are coloured the coloration is mostly uniform, without spots or bands, and without the belly being paler than the back and sides. A few are silvery (e. g. *Lepidopus*, 971).

Many fishes obtained from great depths come to the surface in a damaged condition owing to the expansion of the gases in the tissues of the body when relieved from the great pressure to which they are subjected at the bottom of the sea. For this reason few

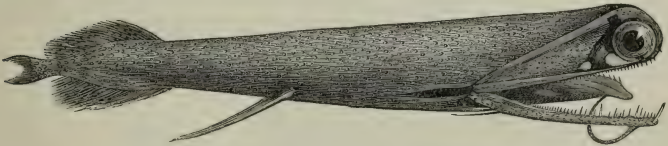


FIG. 5.—A Deep-sea Fish, *Malacosteus indicus*.
(From Boulenger, Camb. Nat. Hist. vii, 1904, after Günther.)

are suitable for exhibition, and most of the specimens shown in Cabinet-case 44 are models, some of them enlarged, made to present as nearly as possible the appearance that the fishes would offer in their natural state.

Most of the deep-sea fishes are known by a few specimens only, and, being rare, they have no popular names.

Aulostomatomorpha (984) is a curious fish in which almost the whole of the skin of the head is phosphorescent ; in *Malacosteus* (979, and fig. 5) there are two photophores or luminous organs situated below and behind the large eye ; in *Ipnops* (976) the eyes are wanting and the top of the broad, flat head is occupied by a pair of large photophores, which nearly touch one another in the middle line.

Gastrostomus (985, fig. 6 *a*) and *Saccopharynx* (986, fig. 6 *b*) are related to the Eels; they are predaceous fishes, with the eyes set

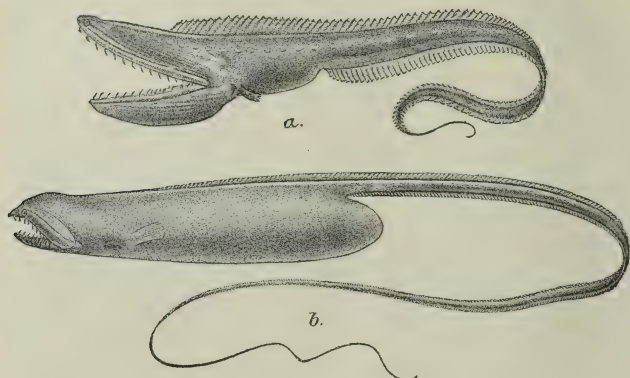


FIG. 6.—Two Deep-sea Fishes allied to the Eels: *a*, *Gastrostomus bairdi*, and *b*, *Saccopharynx flagellum*.

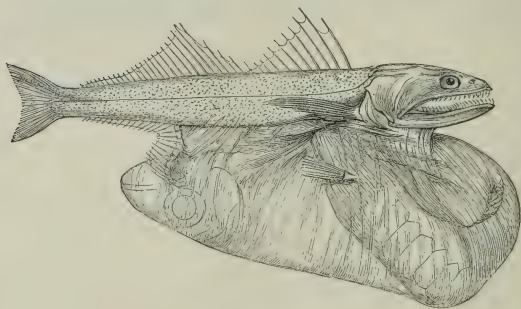


FIG. 7.—A Deep-sea Fish, *Chiasmodon nigrum*.
(From Günther, "Study of Fishes".)

very far forward, and with a long tail tapering off to a thread. The former fish is remarkable for the enormous size of the mouth. Both are provided with a highly distensible stomach and abdominal

wall, by virtue of which the shape of the fish is greatly changed after a good meal. In the case of *Saccopharynx* (986), for instance, the size of the abdomen is due to the fish having swallowed another fish of considerable size shortly before it was itself caught. A still more remarkable case is that of *Chiasmodon* (978, fig. 7), which prior to capture had devoured a fish larger than itself, and the shape of which was clearly discernible through the tightly stretched wall of the distended abdomen when the fish came to hand.

Chauliodus (975, and fig. 8) is a fairly common deep-sea fish, chiefly remarkable for the great length of its teeth. *Bathypterois* (983) is a small-eyed fish presenting a great elongation of the uppermost ray of the pectoral fin and the foremost two rays of the pelvic fin; these filamentous rays are doubtless used as "feelers." A similar function may be attributed to the rays of the paired fins of *Paraliparis* (973), a fish allied to the Sea-snails (*Liparis*, 836 and 837, Wall-case 19) of the English coast.



FIG. 8.—A Deep-sea Fish, *Chauliodus sloanii*.
(From Günther, "Study of Fishes.")

Dolopichthys (972) is a fish belonging to the Ceratiidæ, a deep-sea family related to the Angler-fishes. The "lure," which serves as a bait to induce the prey to come within reach of the jaws, and which is suspended from the end of a long fin-ray of the dorsal fin, is in *Dolopichthys* a luminous structure.

The fishes represented in Cabinet-case 44 are only the most striking and exceptional of the deep-sea fishes. Those less modified are shown in the systematic series in the Wall-cases.

Following Cabinet-case 44, in a series along the side of the Gallery, are four Table-cases (45-48) with a skeleton of the Porbeagle Shark, *Lamna cornubica* (see the specimen in the upper part of Wall-case 1, see also page 32); a Jew-fish, *Stereolepis gigas*, a Sea-perch allied to the large specimen in Table-case 40 in a corresponding position on the other side of the Gallery; a Southern Meagre, *Sciæna antarctica*, and a skeleton of the Common Meagre, *Sciæna aquila* (family Sciænidae, Wall-case 13; see also page 151); and another form of Meagre, *Sciæna diacanthus*, from the estuaries of Bengal.

SYSTEMATIC SERIES IN THE WALL-CASES.

In Wall-case 1, in the S.W. corner of the Gallery are exhibited the more primitive of the Sharks and Dog-fishes; the series of Sharks and Dog-fishes is continued in Wall-case 2 and ends with the Monk-fish and *Pristiophorus*. In Wall-cases 3 and 4 are shown the Saw-fishes, Skates and Rays, and in the lower part of Wall-case 4 reference is made to the extinct Pleuracanthodian Sharks. Wall-case 5 is devoted to the Holocephali and Ostracodermi. The Dipnoi or Lung-fishes occupy the first part of Wall-case 6, the Stylopterygii or Fringe-finned fishes, and the Sturgeons and Gar-pikes fill up the rest of the case. In Wall-case 7 are the Amioid fishes and their extinct relatives, also the lower Teleostean fishes, the Herring-like and Salmon-like fishes. Wall-case 8 contains the Carps and their allies, and, on the floor, the Eels; the Cat-fishes occupy the corner case (9) and a part of Wall-case 10, the rest of which is filled by the Pikes, Sticklebacks, Sea-horses, Pipe-fishes, &c.

In Wall-case 11 are shown the Grey Mulletts, Flying-fishes, and Barracudas, and the Cod-like fishes. In the corner case (12) begins the great series of fishes with spiny fin-rays in the dorsal, anal and pelvic fins (Acanthopterygian fishes), a series which continues along the whole of the East side of the Gallery up to Wall-case 19. The first fishes of the series are the Berycid

fishes, in Wall-case 12, together with the Archer-fish and the Perch, and in Wall-case 13 there follow the Sea-perches, Basses and Meagres. The Snappers, Sea-Breams, Red Mulletts and Chætodont fishes are shown in Wall-case 14, and the Surgeon-fishes, Parrot-fishes, Wrasses and Mackerel-like fishes in Wall-case 15.

The small Wall-case 16 is devoted to the Horse-Mackerels, and Wall-case 17 to the Frost-fishes and Dolphin-fishes. Wall-case 18 includes the Dorys, the Flat-fishes, such as the Sole, Plaice and Turbot, and the Sucking-fishes and Gobies. In the upper part of Wall-case 19 are exhibited life-sized coloured drawings of the Ribbon-fishes, and in other parts of the case are specimens of Gurnards, Lump-suckers and Blennies. The systematic series ends with Wall-case 20, which contains the Angler-fishes (on the floor), the File-fishes, Globe-fishes and Sun-fishes.

ELASMOBRANCHII (Sharks and Rays).

The Elasmobranchii, including the Sharks, Dog-fishes, Saw-fishes, Skates and Rays, are marine fishes with a skeleton composed of cartilage, the surface of which is usually calcified, but does not exhibit the characters of true bone. The skin possesses tooth-like structures called placoid spines, which when closely set constitute shagreen. The vertebral column is in most instances continued into the upper part of the tail fin, and the lower lobe is small as compared with the upper; such a tail is known as "heterocercal." The fins are supported by closely-set rods and plates of cartilage in the basal parts, and by horny fin-rays in the marginal parts (see specimen 3). There is no gill-cover, and, with a few exceptions, five gill-slits open on each side of the body. The heart has a chamber known as the *conus arteriosus*, which is provided with watch-pocket valves that prevent the return of blood to the ventricle (see dissection 2). The intestine has a spiral valve (see dissection 1) and there is no swim-bladder. The ova or egg-cells are large, and undergo their development either within the body of

Wall-
case 1.

the mother or within horny egg-shells (see specimens 7, 4, 5, 6 and fig. 9). In the scheme of classification adopted in this Gallery

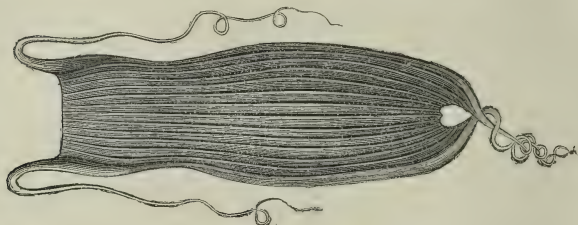


FIG. 9.—Egg of a Dog-fish of the genus *Scyllium*.
(From Günther, "Study of Fishes.")

(see pp. 200–201) the Elasmobranchii are divided into four orders, Proselachii, Acanthodides, Selachii, and Pleuracanthodes.

PROSELACHII (Primeval Sharks).

The Proselachii or Pleuropterygii are extinct Sharks, the most primitive as well as the most ancient of the Elasmobranchii. The only genus of which the general structure is at all well known is *Cladoselache* (fig. 10), but detached teeth resembling those of *Cladoselache* have long been known in the Carboniferous formations under the name of *Cladodus* (see tooth of *Cladodus striatus*, 10). The gill-slits are five or more in number; the upper and lower jaws are approximately equal in size and are suspended from the cranium by the hyomandibular cartilage. The dorsal and the paired fins are supported by parallel fin-rays of calcified cartilage which extend nearly to the margin of the fin. Dermal fin-rays have been described in the posterior edge of the fin, but the evidence of their presence is unsatisfactory (see pectoral fin, 8). The length of these Sharks varies between two and six feet.

The remains of *Cladoselache fylleri*, found in the Cleveland Shale (Upper Devonian or Lower Carboniferous) of Ohio, are sufficient to show that the form of the body was rounded and

elongated (see fig. 10, and the enlarged drawing 9 at the top of Wall-case 1). Two dorsal fins are present, but no anal fin. The caudal portion of the vertebral axis is strongly upturned, and distinctly hinged upon the rest of the vertebral column, but the outline of the tail is symmetrical about a horizontal plane. A

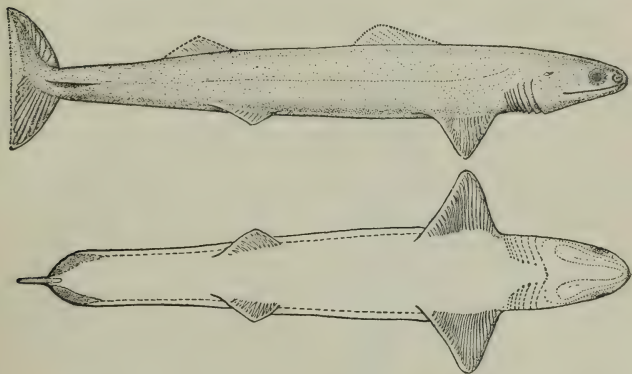


FIG. 10.—An extinct and archaic Shark, *Cladoselache fylei*, side and ventral views, restored.

(From Bridge, Camb. Nat. Hist., vii, 1904, after B. Dean.)

short dermal expansion forms a horizontal keel on each side of the base of the tail. No calcifications are recognisable in the sheath of the notochord; the skeletal cartilages are calcified in the form of cubes, closely fitting like a mosaic. The teeth are of various forms, each with a principal cusp and a variable number of lateral cusps. The eye has a ring of small dermal plates; the remainder of the body is covered with minute denticles.

ACANTHODIDES (Acanthodian Sharks).

The Acanthodian fishes are Palæozoic Sharks of small size, rarely exceeding one foot in length. The restoration of *Climatius* shown (11) is about four times the natural size (linear). The

Climatius.

placoids of the skin are flattened and closely fitted together. The calcifications of the cranium, jaws, and pectoral girdle present the appearance of membrane bones, although bone cells are wanting. The fins, both paired and median (except the caudal), bear each a stout spine along the front edge, and in some cases there occur between the pectoral and pelvic fin of each side a row of four or five spines of a similar nature (see 11, and fig. 11). The cartilaginous supports of the fins must have been insignificant, and the fin-membranes but feebly supported by dermal fin-rays. The earlier forms, those of the Upper Silurian and Lower Devonian, are included in the family Diplacanthidæ (e. g. *Diplacanthus* and *Climatius*); these have two dorsal fins. The family Acanthodidæ (e. g. *Acanthodes*) includes the later forms, those ranging from the Lower Devonian to the Lower Permian, which have but a single dorsal fin, and pelvic fins of smaller size than the pectorals. In *Climatius* (11) the fin-spines are remarkably broad, and are marked with coarse longitudinal ridges. The most perfect specimens known are about seven inches in length, but fragments have been found of specimens which must have measured eighteen inches or more when complete.

SELACHII (Modern Sharks and Rays).

The order Selachii includes all the modern Sharks and Rays, and a number of extinct forms as well. The great majority of the Selachii are marine, but a few species live in fresh water. The denticles of the skin are closely set to form shagreen, but in the Rays there is a tendency for the spines to become fewer and larger. The calcifications on the surface of the cartilages do not resemble membrane bones, and have not the microscopic structure of true bone. The basal cartilages of the pectoral fin, namely, those in contact with the pectoral girdle, are usually three in number, less commonly two; there is no long segmented axis to the fin. With a few exceptions the vertebral centra are well calcified, but the form of the calcified layers varies considerably (compare specimens 20, 28, 65, 80, 85, 90, 113 in Wall-cases 1-4). The Selachii range back to Carboniferous and Permian times. The suborders recognised are :—Notidani, Squali, and Raii.

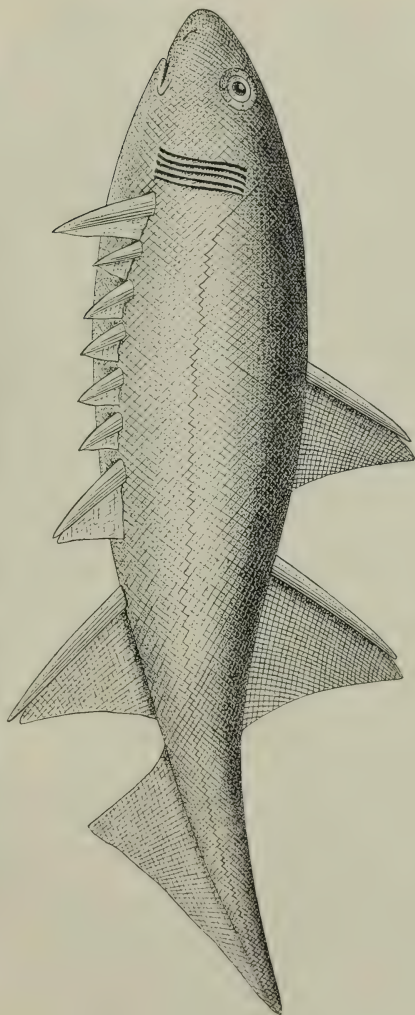


FIG. 11.—An Acanthodian Shark, *Clinacanth maculicollis*, restored.

NOTIDANI (Notidanid Sharks).

The Notidani constitute a small suborder of archaic Sharks in which the gill-openings are six or seven on each side of the body. The vertebral column is imperfectly segmented, and the centra are feebly if at all calcified; there is but a single dorsal fin, which is set rather far back, opposite the anal fin. There is no nictitating membrane or third eyelid, such as occurs in some Sharks (*e. g.* 67, Wall-case 2). There are two families, the Chlamydoselachidæ and the Notidanidæ.

Chlamy-
dosela-
chus.

The family Chlamydoselachidæ includes but a single genus, *Chlamydoselachus*, a long, slender-bodied Shark (specimen 12, and fig. 12) found in the deep seas of many parts of the world, and first obtained off the coast of Japan in 1884. The head is depressed, and the mouth is terminal. There are six pairs of gill-openings, with backwardly directed frills or flaps of skin, whence the popular name "Frisled Shark" given to this fish. The skull is hyostylic, *i. e.* the jaws are suspended from the cranium by means of the upper element of the hyoid arch (for illustration of "hyostylic" see specimen 18). The teeth are of primitive character and several rows are simultaneously in use; the crown consists of three slender curved cusps, separated by a pair of small denticles; the embedded bases are broad and backwardly extended, and overlap one another in the gum.

Noti-
danus.

In the Notidanidæ the skull differs from that of the previous family in being "amphistylic," *i. e.* the jaws are connected with the cranium or brain-case in two ways, by a direct articulation between the upper jaw and the optic region of the cranium, and by means of the hyomandibular cartilage, or upper piece of the

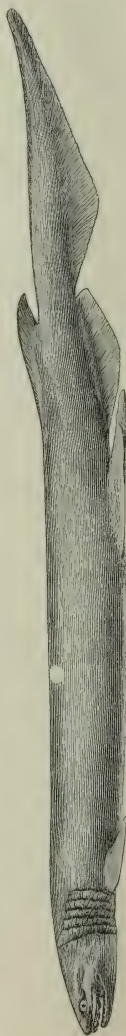


FIG. 12.—Frisled Shark, *Chlamydoselachus anguineus*.

hyoid arch, which is much more slender than is usual in Sharks (see skull of *Notidanus*, 13, and compare with the hyostylic skull of *Scyllium*, 18). The mouth is inferior; the gill-clefts are six in number on each side in *Hexanchus* and seven in *Heptanchus*; there are no flaps or frills over the gill-clefts. The teeth have a characteristic form (see 15, and fig. 13), and in the lower jaw only one row of them is in use at a time. The principal teeth in their most perfect development possess

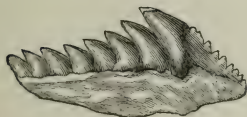


FIG. 13.—Tooth of *Notidanus gigas*.

a number of backwardly-sloping compressed cusps arising from a long base; the anterior edge of the first cusp is finely serrated. The teeth at the front of the upper jaw are smaller, and have each a single awl-shaped cusp with one or more small lateral cusps. The teeth of *Notidanus* are found in rocks as old as the Jurassic; examples are shown (16 A and B) of fossil teeth of Tertiary age. The Notidanid Sharks attain to a length of fifteen feet, and are distributed over the tropical and sub-tropical seas. In Wall-case 1 is shown a small specimen of the Perlon or Seven-gilled Shark, *Notidanus (Heptanchus) indicus*, 14, and suspended from the rail in front of the case is a Grey Shark, or Six-gilled Shark, *Notidanus (Hexanchus) griseus*, 1141, caught off the Orkney Isles.

SQUALI (Sharks and Dog-fishes).

In the suborder Squali are included all the Sharks and Dog-fishes except the few embraced in the former suborder, the Notidani. There are two dorsal fins instead of one and the gill-clefts are five in number on each side. These fishes differ from those of the following suborder, the Raii (Wall-case 3), in the gill-clefts being laterally placed, and in the body being of the usual Shark type, without any great enlargement of the pectoral fins or flattening of the body. The Rhinidæ show a tendency to modification in these directions, although they do not necessarily lead on to the Rays. It is convenient to divide the suborder into two groups, which may be designated Group A and Group B.

Group A
of Squali.

In the fishes of Group A an anal fin is present between the cloaca and the tail fin, and there is a tendency for the spiracle to become reduced in size. The vertebral centra are astero-spondylic, *i. e.* if viewed in transverse section they are seen to be strengthened by calcified ridges or radiating laminæ which predominate over the concentrically disposed laminæ (compare the asterospondylic vertebræ of *Cestracion* (20) and *Scyllium* (28) with the tecto-spondylic vertebræ of *Rhina* (90, Wall-case 2). Group A

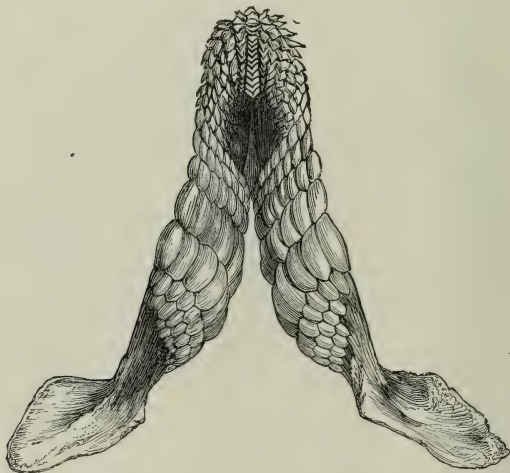


FIG. 14.—Upper jaw of Port Jackson Shark, *Cestracion philippi*.
(From Günther, "Study of Fishes.")

includes the families Cestraciontidæ, Cochlodontidæ, Scylliidæ, Lamnidæ, Rhinodontidæ, and Carchariidæ.

Port
Jackson
Shark.

In the family Cestraciontidæ, the best-known example of which is the Port Jackson Shark (24), each of the two dorsal fins is armed with a stout spine (see spine, 24 A), and the first dorsal fin is opposite the space between the pectoral and pelvic fins. The nasal and buccal cavities are confluent; there is no nictitating membrane; the teeth, except those at the front of the mouth, are blunt, and adapted for crushing the shells of molluscs and crustaceans (see jaws, 19, and fig. 14). Sharks of this family

existed in Carboniferous times and were more numerous in Palæozoic and Mesozoic periods than at the present day.

In *Cestracion* the mouth is rather narrow and nearly terminal. The spiracle is small and situated below the posterior part of the eye; the gill openings are rather small. The dorsal fin-spines are smooth and with no posterior serrations such as occur in *Hybodus* (see spine, 21, and fig. 15). The jaws are suspended by

the hyomandibular cartilage, but the upper jaw also enters into extensive articulation with the ethmoid region of the cranium (see skull of *Cestracion galeatus*, 17; the more usual type of hyostylic skull found in Sharks is illustrated by a skull of *Scyllium*, 18). The vertebral centra of *Cestracion* are asterospondylic (see 20), but the radiating arrangement of the secondary laminae of calcareous matter does not occur in the more ancient genera of the family, e. g. *Hybodus* and *Palæospinax*. The egg-shell of *Cestracion* has a curious spiral flange projecting from its surface (see 6).

The species of *Cestracion* occur in the seas of Australia, Japan, California, &c. The specimen 24 shown in Wall-case 1 is a small example of the Port Jackson Shark; a larger specimen (four feet long) is shown in the Table-case 23, in the centre line of the Gallery; a full-sized individual is about five feet long. For comparison with the teeth of *Cestracion* (19) are shown the teeth of the extinct *Acrodus* (22) and *Asteracanthus* (23).

The Sharks of the family Cochliodontidæ flourished in Carboniferous times, and their remains are practically confined to the rocks of that age. The dentition differs from that of the Cestraciontidæ in one or more of the

Cochli-
odontus.



FIG. 15.—Dorsal fin-spine of *Hybodus*.
(From Günther, "Study of Fishes.")

transverse series of teeth being fused into a continuous curved plate. Whereas in *Cestracion* the reserve members of the series of crushing teeth arise as separate teeth on the lingual or inner

side of those in use, in *Cochliodus* the teeth are coalesced into a continuous plate, which receives additions to its lingual border and slowly moves outward and forward in a spiral manner over the surface of the jaw. Two views are given of the dental scroll of *Cochliodus*, 25 and 26 (see also fig. 16).

In the family Scylliidae the dorsal fins have no spines; the first is situated above or behind the pelvic fins. The spiracle is distinct; there is no nictitating membrane. The teeth are small and several series are in use at the same time. The nasal and buccal cavities are more or less confluent; the fourth and fifth gill-slits are close together in the genera *Chiloscyllium*, *Crossorhinus*, *Ginglymostoma*, and *Stegostoma*, but not in *Scyllium*. The common Dog-fish of the South coast of England is *Scyllium canicula*, 30. The term "Dog-fish" is applied loosely to any small Shark-like fish, the difference between a Dog-fish and a Shark being one of size only*. The Dog-fishes found around the British coast include the one just mentioned, *Scyllium canicula*, 30, the Smaller Spotted Dog-fish; the Larger Spotted Dog-fish or Nurse Hound, *Scyllium catulus*, 27; and the following three which do not belong to the family at present under consideration, the Piked Dog-fish, *Acanthias vulgaris* (75, in Wall-case 2), a Dog-fish which on the East coast is more common than the Spotted Dog-fish; the Smooth Hound, *Mustelus vulgaris* (68, Wall-case 2), and the Tope, *Galeus canis* (64, Wall-case 2). The commonest of these are the Smaller Spotted Dog-fish and the Piked Dog-fish, which in some parts of the coast are sufficiently plentiful to prove troublesome to fishermen by taking the bait intended for more valuable fish.

The Spotted Dog-fishes are ground feeders and live mostly on crustaceans and molluscs, and they keep fairly close to the land. On some parts of the coast these Dog-fishes are eaten, but the flesh is not in great favour. The smaller Dog-fish is distinguished from



FIG. 16.—Jaw with tooth-plates of *Cochliodus contortus*.

(From Günther, "Study of Fishes.")

* This does not apply to extinct forms. Acanthodian fishes, for instance, rarely exceed a foot in length, but it is customary to speak of them as "Sharks."

Dog-fishes.

Spotted Dog-fish.

the larger, not only by its smaller size, but by its anal fin being situated farther forward as compared with the second dorsal fin, and the right and left nasal flaps are nearly continuous in front of the mouth, whereas in *Scyllium catulus* they are some distance apart. These Dog-fishes lay pillow-shaped eggs with a flexible yellow-brown or black egg-shell, the four corners of which are produced into tendril-like threads which serve to anchor the egg to sea-weed and rocks (see specimen 4 in the introductory series below the label "*Elasmobranchii*"). Two eggs are laid at a time, and five or six months elapse before the embryo fish hatches out.

The Black-mouthed Dog-fish, *Pristiurus melanostomus*, 31, is a small Dog-fish common in the Mediterranean and occasionally caught in British seas; it has a series of small flat spines on each side of the upper edge of the tail fin. The genus *Ginglymostoma* includes Sharks some of which grow to twelve feet in length, with small eyes and minute spiracles; they are of pelagic habit and occur in the warmer parts of the Atlantic and Indian Oceans. The specimen of *Ginglymostoma brevicaudatum* shown (33) is small, the jaws of the same species (34) give an idea of the size to which the fish grows. A specimen of *Ginglymostoma cirrhatum* (36) is shown on the floor of the case, and another specimen hangs from the rail opposite Wall-case 2.

In *Chiloscyllium* (e. g. *Chiloscyllium indicum*, 35) the anal fin is far behind the second dorsal, and is almost continuous with the caudal fin; the genus includes several species of small Dog-fishes occurring in the Indian Ocean and adjacent seas. *Stegostoma* resembles *Chiloscyllium* in the backward situation of the anal fin, but the spiracle is behind the eye instead of below it; the eye is very small, the snout very blunt, and the upper lip thick. The Zebra Shark, *Stegostoma tigrinum*, is one of the commonest Sharks of the Indian Ocean. In the young (e. g. 38) the tail fin is proportionately much larger than in the adult (37), and the colour-markings are more pronounced. This last feature is not uncommon in Elasmobranch fishes, the young of many Dog-fishes, Sharks, and Rays being brightly banded or spotted, whereas the adults are of a uniform and dull coloration. *Crossorhinus* (39) has a broad, flat head with blunt snout and lateral projections of skin; the mouth is wide and nearly terminal; the eye is small and

Zebra
Shark.

the spiracle is a wide slit behind the eye. These fishes are ground Sharks occurring off the coasts of Japan, Australia, &c., and attaining a length of ten feet.

In the Lamnid Sharks (family Lamnidae) the dorsal fins are without spines, and the first is situated opposite to the space between the pectoral and pelvic fins. There is no nictitating membrane; the gill openings are generally large; the spiracle is minute or absent. The teeth are large and cuspidate and the bases are compressed antero-posteriorly, and thus differ from the

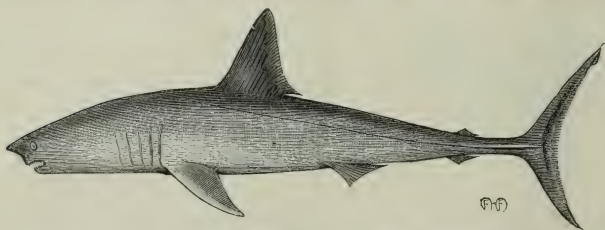


FIG. 17.—Porbeagle Shark, *Lamna cornubica*.

stout depressed bases of the teeth in the more ancient Sharks, such as those already considered. The teeth are solid when completely formed. The Lamnid Sharks attain to a large size and are pelagic in habit.

Porbeagle. The Porbeagle Shark, *Lamna cornubica* (fig. 17) grows to ten feet in length and is occasionally caught off the British coasts; the specimen which hangs from the top of Wall-case 1 (specimen 40) was caught at Skye. The Mackerel Shark, *Lamna spallanzanii*, differs but little from the Porbeagle; the jaws of this Shark are exhibited (41), and a cast of a specimen caught on the Atlantic coast of North America is shown on Table 25 in the middle of the other end of the Gallery. The teeth are large and lanceolate and serve merely for seizing the fishes upon which these Sharks prey.

Great Blue Shark. In *Carcharodon* the teeth are large, erect, triangular and serrated along the edge (see jaws 44). The most formidable of modern Sharks belong to the genus *Carcharodon*. A Great Blue Shark or Man-eater Shark, *Carcharodon rondeletii*, is shown on Table 25 at the other end of the Gallery, also the jaws of a much larger specimen, similar to the jaws in Wall-Case 1. The Great Blue Shark is known to grow to forty feet in length;

some of the extinct species of *Carcharodon* must have been vastly larger, judging by the great size of the teeth (e.g. 43) that are found in Eocene, Miocene, and Pliocene strata.

The Thresher or Fox Shark, *Alopias vulpes* (1139, hanging from Thresher.



FIG. 18.—Thresher Shark, *Alopias vulpes*.

the rail opposite Wall-Case 3, and fig. 18), has an extremely long tail fin, and has not the paired longitudinal keel at the side of the tail that is present in the Sharks of the two preceding genera. The Thresher is common on the British coasts; it feeds on Herrings, Pilchards, and Sprats, and attains to a length of fifteen feet, one half of which is taken up by the tail.

In the genus *Odontaspis* (46, and specimen 1123, hanging from the rail opposite Wall-case 20) the second dorsal fin and the anal fin are not so reduced in size as they are in the genera *Lamna*, *Carcharodon* and *Alopias*, and there is no tip on the upper surface of the root of the tail. The teeth are long and lanceolate, with one or two small cusps at the base of the main cusp (see jaws 47, and fig. 19).



FIG. 19.
Tooth of
Odontaspis
elegans.

The Elfin Shark, *Mitsukurina owstoni*, is closely allied to *Odontaspis*, but differs in the shape of the snout, which projects beyond the jaws to a considerable extent (see 1124, hanging from the rail opposite Wall-case 19). It is even more closely allied to the extinct *Scapanorhynchus* of the Upper Cretaceous strata of Syria. The Elfin Shark is a deep-sea Shark first caught in the year 1898 in the seas of Japan. The

Elfin
Shark.

tail is longer than that of *Odontaspis* and is nearly in a line with the body. The Shark grows to about twelve feet in length.

The Basking Shark, *Selache maxima* or *Cetorhinus maximus* (see fig. 2, p. 8), is a great Shark growing to 33 feet or more, and widely distributed in northern seas. In Wall-case 1 the Shark

Basking
Shark.

is represented by a sketch of a 28 foot specimen caught off the Isle of Wight in 1875, a photograph of a young specimen 11 feet long caught off Brighton in 1903, showing the disproportionately large snout characteristic of young specimens, and a piece of skin prepared to show the manner in which the small, pointed denticles are arranged in patches or groups. Hanging from the roof is a specimen of the Basking Shark, 28 feet long, caught off Bergen in 1904, and below it on the floor is a cast of the skeleton of a specimen of the same size and from the same locality. Within the same enclosure are the head and pelvic fins of the Isle of Wight specimen mentioned above. For further information concerning these specimens see page 9.

Whale
Shark.

The family Rhinodontidæ is a small one, including only the Whale Shark, *Rhinodon typicus*, of which a small specimen is shown suspended from the roof at the other end of the Gallery (see page 10 in the chapter on "Central Exhibits"). A sketch of the Shark (52) is shown in Wall-case 1, also a piece of the dental ribbon (53). The Whale Shark is the largest Shark living at the present day, and attains a length of 50 or 60 feet. It is widely distributed and occurs mainly in the Indian and Pacific Oceans. The snout is flattened, the mouth nearly terminal, the gill-slits of moderate size, the first dorsal fin set above the pelvic fins, and the eyes and the teeth very small. The last gill-slit is above the base of the pectoral fin, whereas in the preceding family, the Lamnidæ, it is in advance of the fin.

Wall-
case 2.

The Sharks of the family Carchariidæ have no spines in the dorsal fins, and the first dorsal fin is situated opposite to the space between the pectoral and pelvic fins. The mouth is crescent-shaped and inferior, and the eye is provided with a nictitating membrane or third eyelid which can be drawn over the exposed part of the eyeball (see 67). The teeth are usually large and cuspidate, and are hollow when completely formed (*cf.* Lamnidæ). No remains of undoubted Carchariid Sharks occur in strata below the Eocene. In *Carcharias* itself the spiracle is absent; there is a pit at the root of the caudal fin, which has a distinct lower lobe; the teeth have a single sharp cusp, mostly compressed and triangular, and the upper teeth usually differ much from the lower. Most of the Sharks of this genus occur in tropical

seas ; the average size is twelve or fifteen feet, but some species attain to a length of twenty-five feet.

The common Blue Shark, so dangerous to persons bathing in the tropics, is *Carcharias glaucus*. The genus is represented in the exhibited series by the White Shark, *Carcharias lamia*, 57 ; the Black-finned Shark, *Carcharias melanopterus*, 58 ; *Carcharias menisorrah*, 60 ; the jaws of *Carcharias acutidens*, 61, and *Carcharias dussumieri*, 59 ; and a specimen of *Carcharias hemiodon*, 1125, suspended from the rail opposite Wall-case 18. In some parts of India and China Shark's fins are used for making soup, the fins being mostly those of Carchariid Sharks. They are sold in the form in which they are exhibited (specimen 70). The trade in Shark's fins is less now than formerly ; in the year 1845 over four hundred tons of them were exported from Bombay to China.

Carcharias.

In the genus *Galeocerdo* the spiracle is minute ; there are pits at the root of the caudal fin, one above and one below. In the terminal lobe of the caudal fin there is a notch, situated

Galeocerdo.



FIG. 20.—*Galeocerdo arcticus*, a Shark of wide distribution.

Also a single tooth of the same Shark.

at the point where the vertebral column ends, which is not present in the other genera of the family. The teeth are subequal in the upper and lower jaws ; they are oblique, serrated on both margins, and have a deep notch on the outer or posterior margin (see teeth 63 and fig. 20). A small specimen of the Tiger Shark, *Galeocerdo tigrinus*, 62, is shown ; hanging from the rail opposite

Wall-case 17 is a fairly large specimen of *Galeocerdo rayneri* (1127) from the Indian Ocean, also the jaws of another specimen (1126).

Tope.

The Tope, *Galeus canis*, 64, is a fish not uncommon on the British coasts, and widely distributed in tropical and temperate seas. It is a bottom-feeder, with a fairly long snout ; the spiracle is minute, and there is no pit at the root of the tail. The jaws of the Tope are exhibited (66) and the calcified parts of the vertebral centra showing the cruciform pattern of the secondary calcification (65). The Smooth Hound, *Mustelus vulgaris*, 68, differs from the Tope in having closely set, flattened teeth, arranged like a pavement (see jaws 69). It is a fish commonly found in British seas ; the species *Mustelus lævis* is occasionally met with also, but it has a more southern distribution than *Mustelus vulgaris*.

Hammer-head
Shark.

The Hammer-head Shark, *Zygæna malleus*, is a strange-looking Shark in which the anterior part of the head is broad, flattened, and laterally elongated ; the eyes are situated at the extremities of the lobes, and the nostrils occur just beneath the front edge ; the spiracle is absent ; the teeth are similar in the upper and lower jaws, they are oblique and have a posterior notch and margins smooth or serrated. The Hammer-head Sharks are found in most temperate and tropical seas. The specimen 71 on the floor of Wall-case 2 is a small one ; a larger example (1129) hangs from the rail opposite Wall-case 16 ; the jaws of a Hammer-head (1128) are shown near the latter specimen.

Group B
of
Squali.

In the fishes of Group B of the suborder Squali the spiracles are large, and the anal fin wanting. The line of the closed mouth is nearly straight, and not crescentic as is so commonly the case in the fishes of Group A. The calcification of the vertebral centra either takes the form of primitive hollow double-cones immediately surrounding the remnants of the notochord, or there are concentric secondary laminae in addition. This group includes the families Spinacidae, Petalodontidae, Pristodontidae, Rhinidae and Pristiophoridae.

Spinacidae.

The family Spinacidae includes fishes, some of which, like *Spinax*, 79, and *Acanthias*, 75, are slender and shapely, while others, such as *Centrina*, 83, and *Echinorhinus*, 86, are bulky and clumsy in appearance. The dorsal fins are provided with spines in some genera (e. g. *Centrina*, *Acanthias*), but not in others (e. g. *Scymnus*, *Echinorhinus*). The body is rounded or triangular in

section ; the mouth is gently arched and the snout obtuse. The pectoral fins are not notched at their bases, and are not produced forward. There is no nictitating membrane ; the gill-slits are small and lateral in position. Remains of Sharks of the family Spinacidæ are not found in strata below the Upper Cretaceous.

Valentin's Sea-hound, *Scymnus lichia*, 73, is a fish common in the Mediterranean and on the coast of Portugal, and occasionally met with in the English Channel. The dorsal fins have no spines and the first is set well in advance of the pelvic fins. The upper teeth are small and pointed ; the lower teeth are much larger than the upper teeth (see jaws 74), they are broad and compressed, triangular and erect, but slightly sloping in the young.

The Piked Dog-fish or Spiny Dog-fish, *Acanthias vulgaris*, 75, has a spine in the anterior edge of each of the dorsal fins (see spines 76). The teeth are similar in the upper and lower jaws ; they are rather small, triangular, and compressed, with the apex much turned aside, so that the inner margin of the tooth forms a cutting edge (see jaws 78). Although the tail fin is not symmetrical above and below the middle line the vertebral column is not uptilted (see tail 77). The Piked Dog-fish has a remarkable distribution, being found in the temperate seas of the northern and southern hemispheres, but not in the intermediate tropical region. It is one of the commonest Dog-fishes around the British coast, and causes much trouble to fishermen by cutting their lines and carrying away the hooks.

Piked
Dog-fish.

The Black Dog-fish, *Spinax niger*, 79, is a small Dog-fish found in most European seas, and common off Portugal and in the Mediterranean. This fish is apparently not black when alive ; freshly taken specimens are very pale in colour (see sketch 98, in Cabinet-case 44, Deep-sea Fishes). The centra (see 80 in Wall-case 2) possess no secondary calcifications, but only the primitive double-cone calcification immediately surrounding the constricted notochord. This type of vertebra is termed 'cyclospondylic,' and is characteristic, among modern fishes, of the Spinacidæ, although it occurs in the more primitive extinct members of other families, *e. g.* in the Liassic genus *Palæospinax*, supposed to belong to the family Cestraciontidæ.

The genus *Centrophorus* includes deep-sea Sharks growing to about five feet in length. Most of them are caught off the coasts

of Portugal and Madeira. Each dorsal fin is provided with a spine, which, however, is sometimes so small as to be hidden below the skin. The mouth is wide ; the lower teeth have the points inclined outward ; the upper teeth are erect and triangular, or narrow and lanceolate, with a single cusp (see jaws 82). In *Centrina* (83) the trunk is rather elevated, triangular in section, with a thick fold of the skin extending along each side of the ventral surface. Each dorsal fin is provided with a strong spine, which is largely concealed in the substance of the fin. The teeth of the lower jaw are erect, triangular, and finely serrated ; those of the upper jaw are slender and conical, and form a group at the front of the jaw (see jaws 84).

Spinous
Shark.

The Spinous Shark, *Echinorhinus spinosus*, 86, has a short bulky body and a short tail. The dorsal fins are small and have no spines ; the first dorsal is opposite to the pelvic fins. The teeth are equal in the upper and lower jaws ; they are very oblique, the point being turned outward, and having one, two or three horizontally directed denticulations on each side. Embedded in the skin are scattered, flat, circular tubercles, each with a small central spine. The nostrils are midway between the mouth and the end of the snout ; the spiracle is small. The Shark lives mostly in deep water ; it occurs in the Mediterranean and the Eastern Atlantic.

Green-
land
Shark.

In the Greenland Shark, *Læmargus borealis* (sketch 87 and specimen 1138 hanging from the rail in front of Wall-case 4) all the fins are small ; the dorsal fins are without spines, and the first is set at a considerable distance in advance of the pelvic fins. The nostrils are near the extremity of the snout ; the jaws are feeble ; the shagreen is uniform. The upper teeth are small, narrow, and conical ; the lower teeth are numerous, each with the point so much turned aside that the inner margin forms a cutting edge. The Greenland Shark is an inhabitant of the Arctic regions and grows to a length of fifteen feet. Although harmless to man it attacks Whales and bites pieces out of their sides.

Angel-
fish.

The Angel-fish or Monk-fish, *Rhina squatina*, 88, is the sole living species of the family Rhinidæ ; the genus is represented in the Lithographic Stone (Upper Jurassic) of Bavaria, where complete skeletons occur. The mouth is anterior and the gill-openings wide and lateral in position. The depression of the body

and the large size of the pectoral fins, and the forward production of their bases towards (but not reaching) the head, suggest an approach to the members of the next suborder, the Raii, although the indication is probably fallacious. The dorsal fins are without spines, and are set upon the tail part of the body. Small tubercles occur embedded in the skin; the teeth are conical and pointed (see jaws 91); the vertebræ (see vertebræ 90) are tecto-spondylic, this term signifying that of the secondary calcified laminæ on the outside of the primary double-cone calcification immediately around the constricted notochord, the concentric laminæ preponderate over the radiating laminæ. In the Angel-fish the concentric laminæ are very numerous and closely set; in the extinct species they are less numerous. This type of vertebra occurs also in the Saw-fishes and Rays, though in a less pronounced form (see vertebra of *Raia*, 113, Wall-case 3). The Angel-fish grows to a length of five feet, and is wide-spread throughout the tropical and temperate seas.

The Petalodontidæ (represented by teeth of *Petalodus*, 92, and *Polyrhizodus*, 93) are extinct fishes, allied to the Angel-fish, which flourished in Carboniferous and Permian times. The body was moderately depressed, the pectoral fins large and continued forward towards the head. The teeth were compressed antero-posteriorly, and formed a close pavement over the surface of the jaw.

In *Pristiophorus*, 94, the sole genus of the family Pristiophoridae, the elongation of the snout to form a rostrum, and the presence of teeth along its edges, suggest an affinity with the Pristidæ or Saw-fishes, the first family of the next suborder, but the body is scarcely depressed, the gill-slits are lateral in position, the pectoral fins are of moderate size, and their bases show no tendency to spread towards the head. On the other hand, the enlargement of the prepalatine cartilages of the skull which is observed in the Pristiophoridae is a feature which in the Rays is definitely associated with the extension of the front of the pectoral fin around the edge of the head. A pair of long barbels occur on the under-side of the 'saw.' The teeth of the mouth are small, with a conical cusp on a broad base. These fishes occur in the seas of Japan and Australia, and attain to no great size.

Pristio-
phorus.

RAII (Saw-fishes and Rays).

Wall-
case 3.

The suborder Raii or Batoidei includes the Saw-fishes, Skates, and Rays. The form of the body is adapted for living on the sea-bottom; the pectoral fins are enlarged, and their front edges encroach round the sides of the head; the tail and median fins are reduced, although these characters are less pronounced in the first two families—the *Pristidæ* and *Rhinobatidæ*—than in those that follow. In the more highly specialised forms the trunk, surrounded by the immensely developed pectoral fins, forms a broad, flat disc, of which the tail appears as a slender appendage (see Sting Rays, Wall-case 4). The cartilaginous rays of the fins are greatly developed and the dermal fin-rays reduced or absent. The eyes and spiracles are on the upper surface of the body, and the five pairs of gill openings on the under surface (see *Raia*, 112). The upper surface is pigmented, the lower pale. The Rays lead a sedentary life at the bottom of the sea and subsist on molluscs, crustaceans, and small fishes; they keep fairly near the coast, only the Eagle Rays being found in the open ocean. Some species occur in fresh water. In the more highly specialised forms progression is effected by the gentle undulation of the long margin of the pectoral fin, and not by a flapping of the whole fin, nor by the lashing of the tail. The mouth opening is ventral, and very slightly if at all curved, and the jaws are correspondingly straight and transverse. The jaws are rounded in section, and several rows of teeth are in use at the same time (see jaws 103 and 116). In the highly specialised Eagle Rays the teeth are flattened plates adapted for crushing (see jaws 122 and 126).

Saw-
fishes.

The *Pristidæ*, or Saw-fishes, are distinguished by the remarkable prolongation of the rostrum of the skull, with its double 'saw' of lateral teeth (see fig. 21). In other respects the *Pristidæ* may be regarded as the least modified of the Batoidei or Raii; they swim freely, and have a body which is long, slightly depressed, and passing gradually into the strong and muscular tail. Although the pectoral fins have grown forward so far as to turn the gill-clefts on to the ventral surface of the body they are not very greatly enlarged. The dorsal fins have no spines; the first is

opposite to the base of the pelvic fins, or nearly so. Remains of the genus *Pristis* are found in Eocene deposits.

The Saw-fishes shown are *Pristis cuspidatus*, 100, in Wall-case 3, *Pristis pectinatus*, 1137, hanging from the rail opposite Wall-case 5, and a large *Pristis perrotteti*, 1120, hanging from the

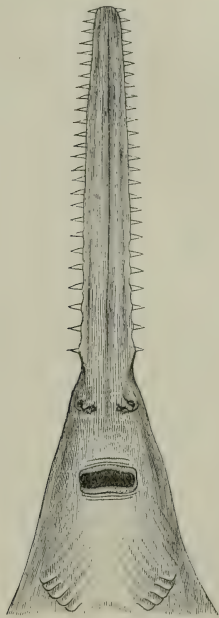


FIG. 21.—Lower view of head of Saw-fish.

roof between Wall-cases 2 and 19. Rostral saws of *Pristis sagittatus*, 99, and *Pristis perrotteti*, 98, are shown in Wall-case 3, and saws of *Pristis zysron*, 1142, and *Pristis antiquorum*, 1143, on the wall between Wall-cases 2 and 3. Saw-fishes are found in tropical and to a less extent in subtropical seas. They attain to a considerable size, the 'saws' of some species measuring six feet in length. The saw is a powerful weapon of attack and is used to rip up the body of some large fish or Whale; the teeth

of the jaws are minute and obtuse, and merely serve to seize the pieces of flesh left projecting from the body of the animal attacked.

The endoskeleton of the rostral saw of the Saw-fish consists of a variable number (usually three) of long tapering tubes (see specimen 101), encrusted with granular calcifications similar to those found upon the other cartilages of the skull. One of these tubes, found detached, remained for a long time a puzzle to naturalists, and was even described in 1864 as the arm of a kind of Star-fish, to which the name *Myriosteon higginsii* was given.

Rhino-
batidæ.

In the Rhinobatidæ, as in the Pristidæ, the tail is long and powerful ; it is provided with two large dorsal fins, without spines, and has a longitudinal fold along each side. The caudal fin is well developed. The trunk is not greatly expanded and the head is not embraced by the pectoral fins. The family is represented by well-preserved skeletons in the Lithographic Stone (Upper Jurassic). Of the recent genera, *Rhynchobatus* and *Rhinobatus* are the most important. In *Rhynchobatus djeddensis* (104) the snout is narrower and more pointed than in *Rhynchobatus ancylostomus* (102), and the calcareous tubercles on the back are smaller ; the undulation of the toothed surface of the jaw is less marked (compare jaws 105 and 103). *Rhinobatus* (e. g. *Rhinobatus granulatus*, 106) differs from *Rhynchobatus* in having the dorsal fins set farther back, and in the caudal fin having no lower lobe ; the front of the skull is produced into a rostrum, and the space between the side of the rostrum and the front part of the pectoral fin is filled by skin. The teeth are obtuse, with an indistinct transverse ridge (see jaws 107). *Rhinobatus granulatus* occurs in the Indian seas ; *R. lentiginosus* is common off Florida, where it is known as the Guitar-fish. *Trygonorhina*, 108, is an Australian genus.

Skates
and
Rays.

In the Raïidæ (Skates and Rays) the disc is broad, rhombic, and generally with dermal asperities or spines. The pectoral fins extend to the snout. The tail has a longitudinal fold on each side, and does not bear barbed spines such as occur in the Sting Rays (Wall-case 4). There is a rudimentary electric organ in the tail. In the Thornback and some other species of *Raia* the teeth are pointed in the male, but blunt and flattened in the female (see 116 and 117). The fishes of the genus *Raia* have a wide geographical

range, but are commonest in the temperate seas, and are more numerous in the northern than in the southern hemisphere. The British species are :—Thornback, *Raia clavata*, 109 ; Homelyn Ray, *R. maculata* ; Starry Ray, *R. radiata* ; Sandy Ray, *R. circularis*, 115 ; Common Skate, *R. batis*, 112 ; Burton Skate, *R. marginata* (see specimen 1079 on the floor beneath the tail of the skeleton of the Basking Shark, within the mahogany rail in the middle of the Gallery) ; Shagreen Ray, *R. fullonica* ; Flapper Skate, *R. macrorhynchus* ; Sharp-nosed Skate, *R. oxyrhynchus*, 111 ; Owl Ray, *R. microcellata*. Some of the Skates attain to a considerable size, the disc of large specimens measuring six or seven feet across. All of the species of *Raia* are marketable fish. The genus dates back to the Upper Cretaceous.

The Thornback, *Raia clavata*, 109, has, in addition to the small asperities of the skin, large, curved spines, with very large embedded bases, arranged on the back and tail (see 110). The specimen of the Common Skate, *Raia batis*, 112, mounted to present its under surface, shows well the paleness of the skin as contrasted with the colouring of the skin of the upper surface (compare with the Sharp-nosed Skate, 111) ; it also shows the mouth as a transverse cleft, set at some distance from the front of the disc, and the five pairs of gill-slits arranged symmetrically near the middle of the under side of the disc. The eyes and spiracles of Skates are on the upper surface (see 111). The eggs of Skates are pillow-shaped, with a process at each of the four corners ; in colour they are brown or black. Empty egg-shells are often to be seen on the beach after a storm (see 114).

In the Myliobatidæ, a family which includes the Eagle Rays and Sea-devils or Devil-fishes, the pectoral fins are of very large size ; they are interrupted at the sides of the head, but reappear as either one or two small cephalic fins at the front of the snout. The tail is very slender ; the cleft of the mouth is straight, and the dentition is in the form of a triturating mosaic-work or pavement, in some cases strongly arched in an antero-posterior direction. The various species of *Dicerobatis*, the Devil-fishes, are the largest of the Rays ; some specimens measure 15 feet across, and weigh over 1000 lbs. A specimen of *Dicerobatis eregoodoo* measuring 9 feet across is suspended from the roof between Wall-cases 6 and

Eagle
Rays.

Devil-
fish.

15; the young specimen 121 exhibited in Wall-case 3 shows equally well the great breadth of the pectoral fins, the pair of cephalic appendages pointing forwards, and the slender tail. The Devil-fishes are mostly found in the tropics, but one species, the Ox Ray or Horned Ray, *Dicerobatis giornæ*, occurs in the Mediterranean and adjacent parts of the Atlantic.

Bishop
Ray.

The Bishop Ray, *Aëtobatis narinari*, is represented by a large specimen suspended from the roof between Wall-cases 5 and 16, and a pair of jaws (122) on the floor of Wall-case 3; the teeth are flat, broad, and in a single series running antero-posteriorly. In *Rhinoptera* the teeth are arranged in five or more series (123),

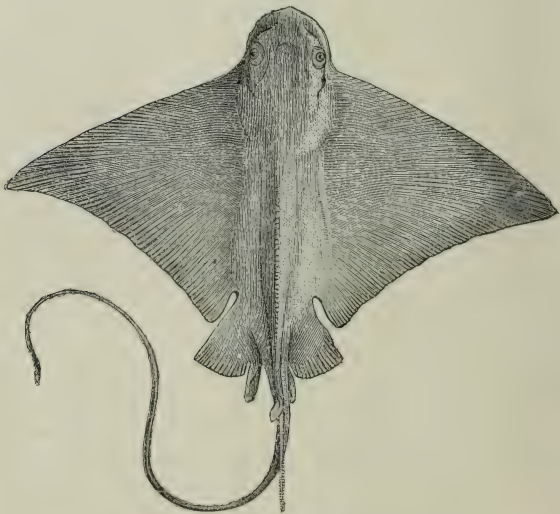


FIG. 22.—Eagle-Ray, *Myliobatis aquila*.

the middle series being the largest, except in young specimens. In the Eagle Ray, *Myliobatis aquila* (fig. 22), of which a specimen is shown (125), the teeth are arranged in seven series (126, and fig. 23); those of the three lateral rows are narrow, but the middle teeth are broad and increase in breadth as age

advances. The condition found in *Aëtobatis* (122), where there are no marginal teeth, thus marks but a further step in the same direction of specialisation. In the Devil-fish, on the other hand,

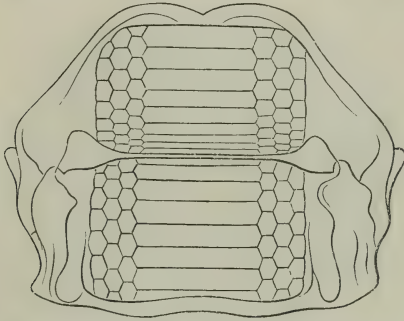


FIG. 23.—Jaws of Eagle-Ray, *Myliobatis aquila*, seen from behind.
(From Günther, "Study of Fishes.")

the teeth are numerous and small. In the extinct (Cretaceous) genus *Ptychodus* the teeth are quadrate in form, with an elevated crown sharply separated from the root (124 A and B). The crown has a series of transverse or radiating ridges, surrounded by a more finely corrugated marginal area.

In the Torpedinidæ or Electric Rays (fig. 24, p. 46) the disc is broad, and the skin smooth and soft. The tail has a longitudinal fold on each side; the caudal fin is present and usually two dorsal fins also. The skeleton of the pectoral fin is not continued forwards beyond the base of the snout. An electric organ capable of giving an electric shock is present between the head and the pectoral fin of each side. The organ (see 120) consists of closely-set hexagonal prisms, vertically disposed, and terminating against the skin of the upper and under surfaces of the body. The electric organ is supplied by branches of the fifth and tenth cranial nerves (trigeminus and vagus). The Torpedo occurs in the Mediterranean Sea and the Indian and Atlantic Oceans (e. g. *Torpedo marmorata*, 119, and fig. 24); one species (*Torpedo hebetans*) is occasionally found off the coast of England (see specimen 1080 on the floor beneath the tail of the skeleton of the Basking Shark, within the

Electric
Ray.

mahogany rail in the middle of the Gallery). The maximum breadth attained by the Torpedo is about three feet, and a fish of this size can by its electric discharge disable a man.

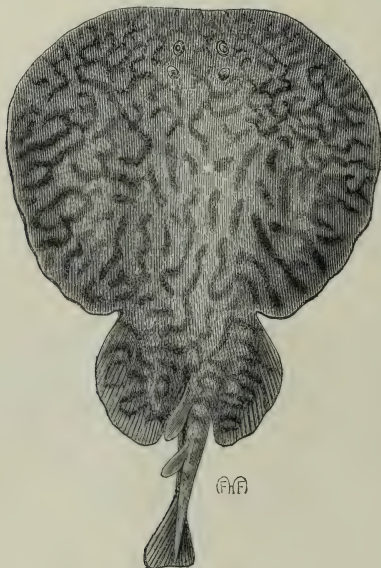


FIG. 24.—Electric Ray, *Torpedo marmorata*.

Wall-
case 4.

The Sting Rays or Trygonidæ (fig. 25) have the pectoral fins continued along the sides of the snout and confluent at its extremity. The tail is slender and sharply marked off from the disc, and has no lateral fold. The dorsal and caudal fins are absent, or are feebly developed. A strong spine, barbed along its sides, occurs on the upper part of the tail; the spine is shed from time to time, and is replaced by a younger one which has been developing behind it. The tail-spine is used as a weapon of defence, and severe lacerated wounds can be inflicted by it. Similar spines are present in some of the Eagle Rays (family Myliobatidæ, Wall-case 3; see 125). The Sting Rays are mainly inhabitants of tropical waters, but one species, *Trygon pastinaca*, 134, occurs off the British coast. Some of the American

Sting
Rays.

species are inhabitants of fresh water. The large specimen (130) in the middle of the case is *Trygon sephen*, from India; near it are shown the tail-spine of *Trygon walga* (132), also from India, and the jaws of *Trygon thalassia* (131). Hanging from the side

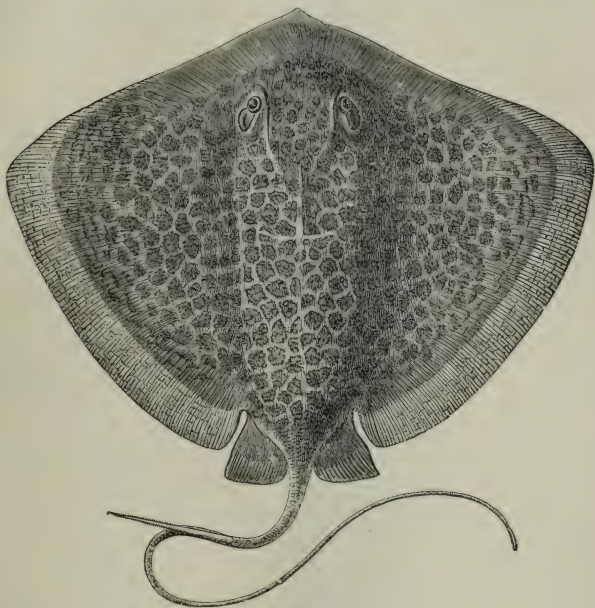


FIG. 25.—A Sting Ray, *Trygon uarnak*.

rail at the other end of the Gallery, opposite Wall-cases 13 and 14, are two other Sting Rays, *Trygon brevicaudata* and *Trygon tuberculata*. Belonging also to the family are *Urogymnus asperimus*, 135, with densely crowded calcareous tubercles in the middle of the back, *Taniura lymma*, 137, with a row of spines along the middle of the back, and the Butterfly Ray, *Pteroplatea micrura*, 138, with a disc twice as broad as long, and with a short, thin tail.

The Trygonidæ do not lay eggs as do the Skates; the young complete their early development within the body of the mother,

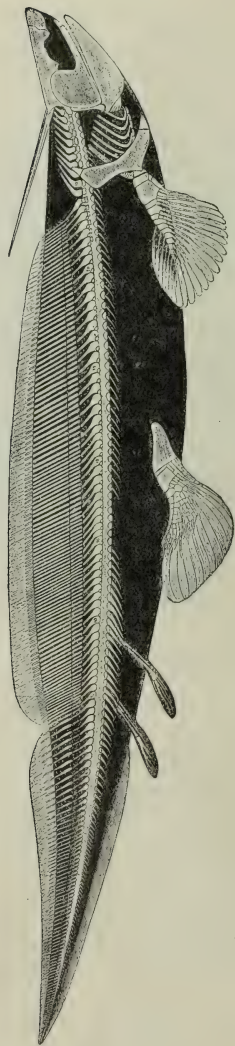


FIG. 26.—A Pleuracanthodian Shark, *Pleuracanthus decheni*, restored. (After A. Fritsch, slightly altered.)

absorbing nourishment from the numerous filaments or 'trophonemata' which project inward from the oviducal wall (see *Trygon bleekeri*, 133, and *Pteroplatea micrura*, 136 A and B). A somewhat similar provision for nourishing the young occurs in the Piked Dog-fish and the Smooth Hound, in which the trophonemata are represented by semicircular lappets of the lining of the uterus, each with a blood-vessel passing round the free edge.

PLEURACANTHODES (Pleuracanthodian Sharks).

The order Pleuracanthodes includes Palæozoic Sharks of primitive type (fig. 26), the remains of which occur in rocks ranging from the Lower Carboniferous to the Lower Permian. The cartilages are permeated with minute granular calcifications, and the cranium sometimes possesses a curious symmetrical fissuring, although there are no true membrane bones. Slight calcifications sometimes occur in the sheath of the notochord. The paired fins have a long segmented axis of cartilage, fringed on one or on both sides with cartilaginous fin-rays, to the extremities of which the dermal fin-rays are attached in bunches (see sketch 141). The median fins are extensive. There is no shagreen, but small scattered tubercles occur in the skin, and there is a median spine projecting from the back of the head.

The restored sketch (natural size) of *Pleuracanthus decheni*, 140, from the Permian Beds of Bohemia, shows the principal characters of these Sharks; the mouth is nearly terminal (fig. 26), the tail tapers evenly and symmetrically, the upper part of the caudal fin is separated by a short break from the dorsal fin, which extends forward nearly to the head, and there are two small anal fins. Remains of other species of *Pleuracanthus* occur in the Coal Measures of France, England, and America. The teeth (see sketch 142) are tricuspid, but the middle denticle being comparatively minute the name *Diplodus* is commonly applied to isolated teeth of the genus.

Pleur-
acanthus.

HOLOCEPHALI (Chimæroid Fishes).

The Chimæroid fishes are fishes of grotesque appearance, occurring mostly in deep water, and related most nearly to the Elasmobranch fishes (Sharks and Rays), although their dentition

Wall-
case 5.

bears some resemblance to that of the Dipnoan fishes (Lung-fishes), consisting of three pairs of tooth-plates (see 151), and the upper jaw is confluent with the cranium, as in the Dipnoi (see skull 148; also 154). The skin is soft and except in the extinct genera has few dermal denticles. The skeleton is cartilaginous, the notochord is persistent, and the calcified rings that occur in its sheath are more numerous than the vertebral segments. The marginal parts of the fins are supported by sheets of closely-set

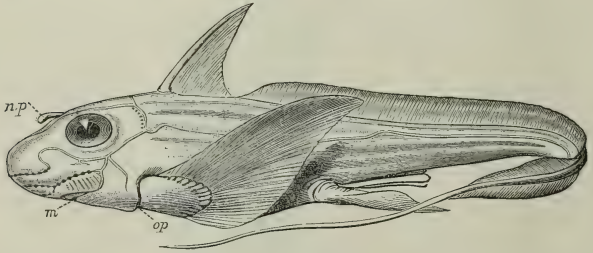


FIG. 27.—Rabbit-fish, *Chimera monstrosa*.

m., mouth; *n.p.*, nasal process, occurring in male only; *op.*, operculum or gill-cover. (After Bridge, Camb. Nat. Hist., vii, 1904.)

horny fin-rays. A spine is present in front of the first dorsal fin. The tail is long and terminates in a filament. The gill-slits do not open separately on the sides of the neck as they do in the Elasmobranchii, but are crowded together beneath a gill-cover (operculum), which is not supported by skeletal parts as it is in bony fishes like the Cod and Mackerel. Spiracles are wanting in the adult. There are valves in the conus arteriosus of the heart, and a spiral valve in the intestine. The intestine opens separately on to the exterior, and not into a common cloaca as it does in the Elasmobranchii. The eggs are large and the egg-shells horny (see 153). In addition to the pelvic claspers, such as occur also in Elasmobranch fishes, the male Chimæroids have a pair of anterior claspers and a curious process arising from the snout (fig. 27, *n.p.*). The subclass is an ancient one; dental plates recognisable as those of Holocephali, and dorsal fin-spines (ichthyodorulites) are found in rocks of Devonian age.

Squaloraia (145) is an extinct Chimæroid, the remains of which occur in the Lower Lias of Lyme Regis. The dentition is simpler than that of the recent Holocephali, and the plates are much thinner.

In *Chimera* (149, and fig. 27) the snout is bluntly conical, and

the mouth is small and situated on the under side of the head. The pectoral fins are large and set low down. The first dorsal fin stands high and is almost continuous with the long second dorsal, which itself is barely separated from the upper part of the tail fin. There is a small anal fin separated by a short interval only from the caudal. The caudal fin-membrane is about as high above as below the axial part of the tail. *Chimæra monstrosa*, the Rabbit-fish, 149, occurs in the Mediterranean and off the west coast of Europe and Africa; it is caught as far north as the Orkney Isles. The American Elephant-fish or Spook-fish, *Chimæra colliei*, occurs in the Pacific Ocean only and is found in less deep water than the other Chimæroids. *Chimæra phantasma* is a Japanese species.

The Southern Elephant-fish, *Callorhynchus antarcticus*, 147, is distinguished by a remarkable cutaneous flap depending from the extremity of the rostrum. The tail is more distinctly heterocercal than in *Chimæra*, and the second dorsal fin is more widely separated from the first. A skeleton of *Callorhynchus* is shown on the floor of the case (146). *Harriotta*, 157, is a fish which grows to about two feet in length; it has an elongated rostrum, large pectoral fins, and the anal fin not separated from the caudal. *Harriotta* occurs in about 1,000 fathoms in the West Atlantic, and was first described in 1894.

Elephant-fish.

The Chimæroid fishes attained their greatest development, both as regards number of genera and the size of the body, in the Cretaceous and Eocene periods. Comparison of the tooth of *Edaphodon sedgwicki* exhibited (155) with that of *Callorhynchus* (148) and *Chimæra* (151) shows how much greater was *Edaphodon* than the modern representatives of the Holocephali.

OSTRACODERMI (Ostracoderm Fishes).

The Ostracodermi are extinct fishes, the remains of which occur in Upper Silurian and Devonian strata. The head region is large and broad; calcified scales occur on the tail, and protective shields on the front part of the body. Grooves on the surface of the plates and shields indicate a well-developed system of dermal sense-organs (lateral-line organs). The notochord was persistent, and there were no differentiated vertebræ. Definite jaws seem to have been wanting, and on account of this feature the Ostracodermi are by some authorities associated with the Cyclostomi

(Lampreys and Hag-fishes). They were probably bottom-feeders and of sluggish habits. The models exhibited were constructed mainly from descriptions and figures in "The Fishes of the Old Red Sandstone," (Palæont. Soc.), by E. Ray Lankester, 1868,

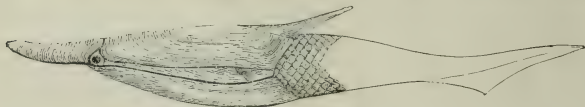


FIG. 28.—Restoration of *Pteraspis rostrata*, side view.

(After A. S. Woodward.)

and R. H. Traquair, 1894, 1902, 1904, and from the Geol. Mag., 1902 (Traquair), and from specimens in the Geological Department of the Museum.

Pteraspis. The first two specimens (160 and 161) show the upper and under surfaces of *Pteraspis rostrata*; the models are $2\frac{1}{2}$ times natural

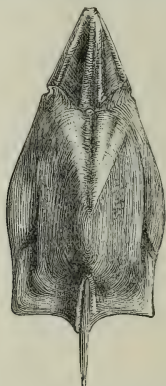


FIG. 29.—Dorsal shield of *Pteraspis rostrata*, upper view.

(After Lankester.)

size (linear enlargement). The hinder part of the tail is not shown, since nothing is known of its shape or length.

In *Pteraspis* (see figs. 28 and 29) the chief body plates are a conical plate in front, a large dorsal plate with a spine projecting from its hinder edge, a pair of long side plates, and a large ventral plate. The ventral plate was at first thought to belong to a different animal, and was named "*Scaphaspis*." The eye is small and lateral, and the exhalant aperture of the gill-chamber is

near the hind end of the lateral plate on each side. The covering of the front part of the tail consists of closely-set rhombic scales. Remains of *Pteraspis* occur in the Lower Old Red Sandstone of England and Scotland, and the Lower Devonian of Galicia.

The models of *Drepanaspis gemündenensis* (162 and 163; see also fig. 30) are of the natural size, and are based on the results of extensive investigations conducted by Dr. R. H. Traquair. The head and trunk region is broad, depressed, and sharply marked off from the tail, which is short, and terminates in a high caudal fin provided with stout marginal scales (fulcra) on its upper and lower edges. The median shields of the dorsal and ventral

Drepan-
aspis.

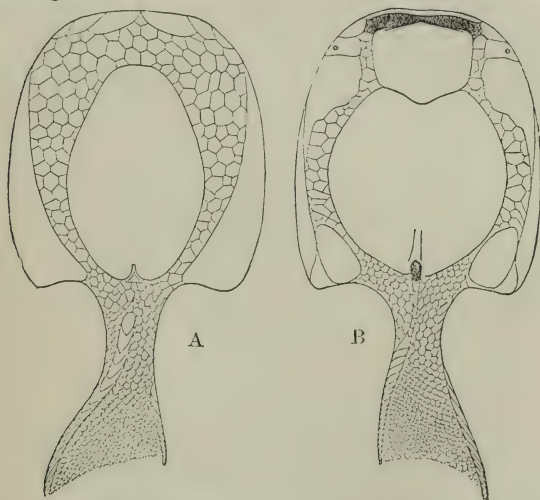


FIG. 30.—Restoration of *Drepanaspis gemündenensis*.

A, upper view; B, lower view. (After R. H. Traquair.)

surfaces are relatively smaller than in *Pteraspis*, and are bounded by a mosaic of small plates. The remains of *Drepanaspis* occur in the Lower Devonian rocks of Gemünden, in Germany.

The model of *Cephalaspis* (164) is enlarged three times (linear). In *Cephalaspis* the eyes are large and fairly close together; there is median dorsal fin and a heterocercal tail. The head-shield of *Cephalaspis* is large, rounded in front, and with a moderately sharp edge. The angles of the head-shield are produced backward,

Cephal-
aspis.

and internally to these projections are movable flaps of elliptical shape above the gill-chambers. The scales on the side of the trunk region are high and narrow. Remains of *Cephalaspis* occur in the Lower Old Red Sandstone of Scotland and the Devonian of Canada.

Pterichthys (fig. 31) is represented by a model of *Pterichthys milleri* (165) enlarged four diameters. In *Pterichthys* the head-plates are so grouped and so separated from the body-plates as to

Pter-
ichthys.

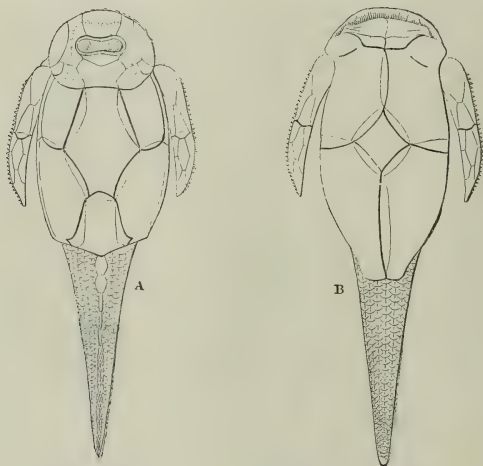


FIG. 31.—Restoration of *Pterichthys testudinarius*.

A, upper view ; B, lower view.

suggest that the head was movable upon the body. The lateral line grooves are well marked ; the eyes are close together. A pair of limbs articulate at the front of the body region and consist of a hollow skeleton of dermal plates, presumably filled in life by muscles, &c. There is a median dorsal fin ; the tail is heterocercal and its sides are covered with imbricated scales. Remains of *Pterichthys* occur in the Lower Old Red Sandstone of Scotland and in the Devonian of the Eifel district. Visitors may be interested to know that a cardboard model of *Pterichthys* constructed by Hugh Miller is on exhibition in the Gallery of Fossil Fishes in the Geological Department of the Museum.

DIPNOI (Lung-fishes).

The Dipnoi are termed 'Lung-fishes' because the existing forms—*Ceratodus*, *Lepidosiren*, and *Protopterus*—have an air-bladder adapted for use as a lung, supplementing and in dry weather supplanting the gills as the organ of respiration. The air-bladder is further comparable with the lung of Amphibians, Reptiles, Birds and Mammals in that it returns the aërated blood direct to the heart, whereas in most fishes the blood from the air-bladder is carried through the general circulation before reaching the heart.

The body is covered with overlapping cycloid scales. The skeleton is largely cartilaginous. The skull consists of cartilage

Wall-
case 6.

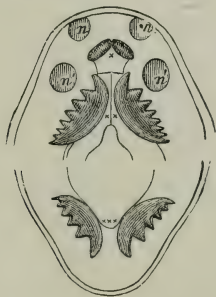


FIG. 32.—Mouth of *Ceratodus forsteri*, widely open to show the nostrils and teeth. *n* and *n'*, narial openings; *x*, vomerine teeth; *xx*, palatopterygoid teeth; *xxx*, mandibular teeth.

covered by membrane bones, *i. e.* bones which are superficial, developed in the membrane covering the cartilage and not formed by the deposition of salts of lime in the cartilage itself. There are no distinctly differentiated maxillary and premaxillary bones (the bones which form the upper jaw in man), and the functional upper jaw (palato-quadrate cartilage) is confluent with the cranium, a condition designated by the expression 'autostylic skull,' a condition also met with in the *Chimæras* (Wall-case 5). The teeth are few, usually three pairs (fig. 32), and

similar to those of the *Chimæras*, namely a pair of mandibular plates below, and a pair of large palatine plates and a pair of small vomerines above. They are tuberculated, as though made up of fused denticles.

The notochord is persistent, with unsegmented sheath and without vertebral centra. The vertebral axis of the tail is uptilted in most of the ancient forms, but the tail has a straight axis and a tapering, symmetrical outline in the recent forms. The paired fins are long and pointed, and each has a central, muscular, scale-covered lobe, and a fringe or marginal membrane supported by closely-set dermal fin-rays.

The gills are covered by a movable operculum or gill-cover, devoid of branchiostegal rays. The nasal sacs open into the mouth (fig. 32, p. 55) as well as on to the exterior of the snout, a condition met with in *Amphibia* and higher *Vertebrates*, but very uncommon in fishes. The conus arteriosus of the heart is spirally twisted, and is provided with several longitudinal rows of valves. The other chambers of the heart are partially divided into right and left parts, the left part carrying the blood from the air-bladder or lung-sac. In the intestine is a spiral valve, and the intestine and the urinary and genital ducts open into a common cloaca. The roof of the mid-brain is not divided into right and left optic lobes, and the optic nerves meet below the brain in the form of a cross or "chiasma."

CTENODIPTERINI.

The *Ctenodipterini* are extinct *Dipnoi* of the Devonian, Carboniferous, and Permian epochs. The skull has numerous roof-bones; the bones of the gill-cover are less reduced, and the body-scales are thicker than in the living *Dipnoi*. The principal families are the *Ctenodontidæ*, *Dipteridæ*, and *Phaneropleuridæ*, represented respectively in Wall-case 6 by a tooth-plate of *Ctenodus* (170), and restored models of the complete fish of *Dipterus* (168, and fig. 33) and *Phaneropleuron* (169, and fig. 33). In the *Dipteridæ* the vertebral axis of the tail is uptilted (heterocercal tail), while in

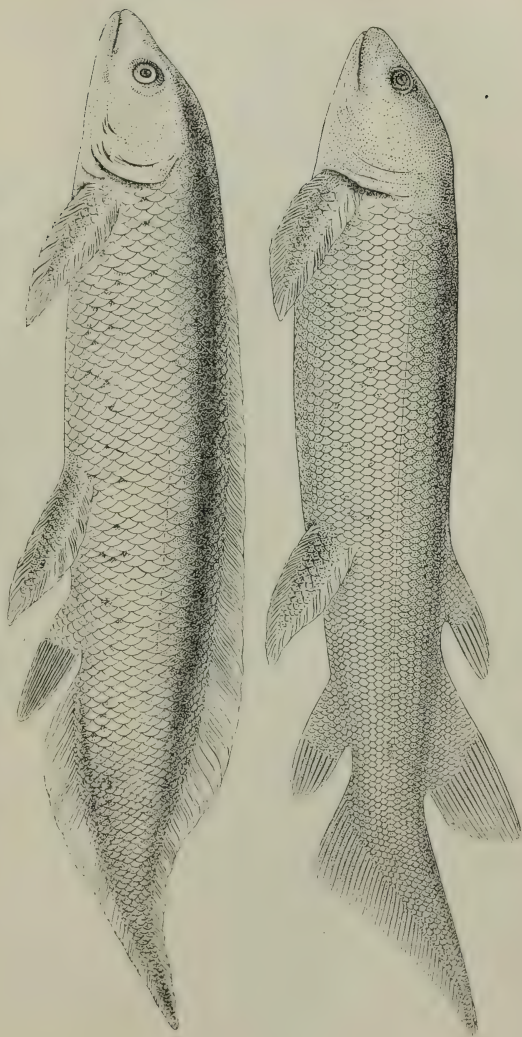


FIG. 33.—Two extinct Lung-fishes, restored; *Dipterus valenciennesi* (upper figure) and *Phareoptychus andersoni* (lower figure).

the other two families the vertebral axis is straight and the outline of the tail symmetrical (diphycercal tail). A distinct anal fin is present in the Phaneropleuridæ and Dipteridæ, and two separate dorsal fins in the latter family.

MONOPNEUMONES.

Cerat-
odus.

In the Monopneumones the lung, or modified air-bladder, is a single organ; it lies to the dorsal side of the alimentary canal, but opens into the ventral wall of the œsophagus. It has a central cavity, communicating with air-cells or alveoli in the thickness of its walls. The Ceratodus or Australian Lung-fish, *Ceratodus forsteri* (171, and fig. 34), which is the sole living representative of the order, lives in the stagnant pools connected with the Burnett and Mary Rivers of Queensland. It is sluggish in habit and feeds on crustaceans, worms and molluscs. It has four pairs of well-developed gills by which aquatic respiration is effected. In the dry season, when the water is thick and foul, and to a less extent at other seasons also, the fish rises occasionally to the surface to empty its lung-sac and to take a fresh supply of air. The Ceratodus grows to a length of five or six feet, and is excellent eating. It was first described in 1870 by Mr. G. Krefft, who recognised the teeth as similar to the teeth of *Ceratodus* which had long been known in a fossil state from the Jurassic rocks. The name 'Barramunda' is sometimes applied to *Ceratodus*, but it is used indiscriminately by the aborigines for any large fresh-water fish, and as often as not is applied to *Osteoglossum* (*Scleropages*) *leichardti*.

The paired fins of the Ceratodus are long and pointed, and each consists of a middle, thick, muscular part or 'lobe', supported by an axial series of cartilages, and two series of obliquely disposed, smaller cartilages in connection with the former, and a fringe or fin-membrane supported by numerous closely-set fin-rays of dermal origin. This type of fin is known as the 'archipterygium', and was formerly regarded as a primitive type of fin. The tail is reduced and symmetrical, and is continuous with the single dorsal and anal fins. The cartilage of the skull is protected by a few large bony plates, covered with skin.

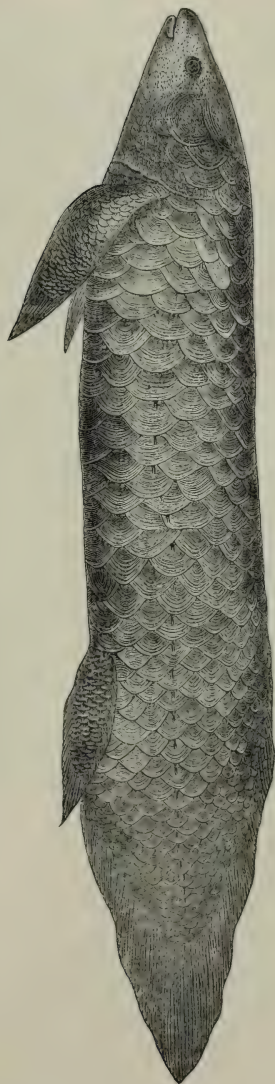


FIG. 34.—Australian Lung-fish *Ceratodus forsteri*.
(From Bridge, Camb. Nat. Hist., vii, 1904, after Günther.)

DIPNEUMONES.

Proto-
pterus.

In the Dipneumones, including the African Lung-fishes, *Protopterus*, 174, 175, 176, and the American Lung-fish, *Lepidosiren*, 173, the lungs are two in number, but they communicate with the œsophagus by a single opening. The gill system is more reduced than in *Ceratodus*, for whereas in that fish four gill-arches bear gills, in the Dipneumones the first and second arches have no gills. In the young there are one or more external gills, projecting freely, and situated above the gill-opening. These have a thick central axis and a fringe, and bear some resemblance to the fins, so much so that some authorities regard the paired limbs of Vertebrates as having been derived by a modification of gill structures. Occasionally the external gills persist, in a reduced form, in adult life. As in *Ceratodus* the tail is reduced and symmetrical, and is continuous with the single, undivided dorsal and anal fins, but the paired fins differ in being more slender and in not possessing the fringe along the front edge.

The genus *Protopterus* has a wide distribution over the continent of Africa, and three species are to be distinguished. The fishes are found in marshes in the vicinity of rivers; they are mainly carnivorous and voracious, and their food consists of frogs, worms and insects. The three species differ in the length of the head, the number of scales in the lateral line, the size of the eyes, and the position of the front end of the dorsal fin. The Gambian Lung-fish, *Protopterus annectens*, 176, has been longest known, the larger species, the Egyptian Lung-fish, *Protopterus æthiopicus*, 175, and the Congo Lung-fish, *Protopterus dolloi*, 174, are comparatively recent discoveries (fig. 35).

At the beginning of the dry season the *Protopterus* buries itself in the thick mud of the swamps in which it lives, and remains curled up in a dormant condition for several months. An opening is left at the upper end of the mud chamber for breathing purposes, respiration during the dry season being effected by the lungs alone. The two dried nodules of clay exhibited (178) contain each a small specimen (now shrivelled up) of *Protopterus annectens*.

Lepido-
siren.

In the South American Lung-fish, *Lepidosiren paradoxa* (173, and fig. 35), the body is long and rounded, and the paired fins

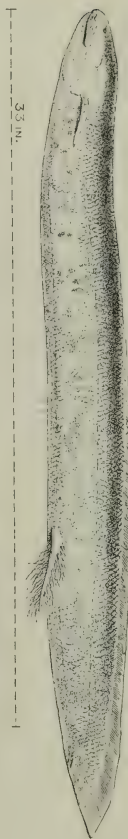
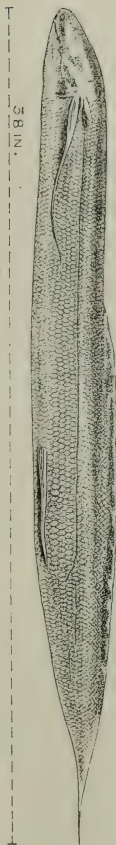
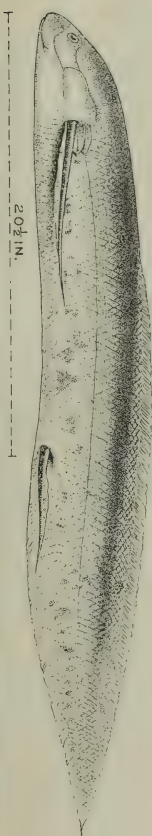
*Protopterus ethiopicus.**Lepidosiren paradoxa.**Protopterus dollioi.**Protopterus annectens.*

FIG. 35.—Lung-fishes. (The fishes are not drawn to the same scale of reduction; the proportional sizes of the four are indicated by the dotted lines, and by the lengths of the fishes in inches written against those lines.)

are so attenuated as to have the form of tapering filaments, devoid of scales and fin-rays. The red structures projecting as tufts from the pelvic fins are highly vascular filaments which are developed in the male during the breeding season, and doubtless act as accessory respiratory organs; they dwindle away after the breeding season. These accessory breathing organs are not altogether without parallel, for in a Siluroid fish, *Plotosus*, there is a median, red, tree-like, branched organ, situated immediately behind the anus and in advance of the anal fin. It is not clear in the case of *Plotosus* whether the organ varies in size at different seasons and whether it occurs in both sexes.

The *Lepidosiren* occurs in the marshes and swamps of the rivers of the central part of the South American continent. It is of sluggish habits and feeds on water-snails and water-weed. It rises to the surface to breathe, making use of the lung-sacs as well as the gills; in the dry season it remains in a torpid condition in the dried mud and breathes by the lungs alone. The flesh is much esteemed as food by the Indians. A series of the eggs and young of *Lepidosiren*, as also those of *Protopterus* and *Ceratodus*, are exhibited in Cabinet-case 29 (specimens 1159, 1160, 1161).

COCCOSTEOMORPHI (Jointed-neck Fishes).

The *Coccosteus*-like fishes (Coccosteomorphi or Arthrodira) are extinct fishes of the Devonian and Lower Carboniferous periods, and are but doubtfully referred to the subclass Dipnoi. The head and front portion of the trunk are covered with large bony plates, the head plates being movably articulated upon those of the body, whence the name Arthrodira (joint-neck). The teeth are somewhat similar to those of *Protopterus*. The vertebral axis appears to have been unossified, but the dorsal and ventral arches and the supports of the single dorsal fin are slightly bony. The tail is heterocercal, and there are evidences of the existence of pelvic fins. A restoration of *Coccosteus decipiens*, of the Lower Old Red Sandstone of North Scotland, is shown in two views, dorsal (180) and

Coccosteus.

side (181). Some of the North American forms of Arthrodiran fishes, such as *Gorgonichthys*, *Dinichthys*, and *Titanichthys*, were of enormous size, some idea of which may be gathered by a comparison of the mandible or lower jaw of *Coccosteus* (182) with that of *Gorgonichthys* (183).

TELEOSTOMI (Fishes with a Maxillary Upper Jaw).

In the Teleostome fishes the lower jaw or mandible is the same morphological element of the skull (namely, Meckel's cartilage and related bones) as in the previous subclasses of fishes, but the upper jaw, which bears usually one or more rows of teeth biting against the mandibular teeth, is not the palatoquadrate cartilage, but consists of bones of dermal origin called premaxilla and maxilla. The upper jaw of the Teleostomi is the equivalent of the upper jaw of the higher vertebrates, namely, Amphibians, Reptiles, Birds and Mammals. The palatoquadrate cartilages are present in the roof of the mouth, but they are reduced, and are of less importance than in the first four subclasses of fishes.

Wall-
case 6.

The gills are pectinate, the gill-filaments being arranged like the teeth of a comb, and they are protected by a gill-cover supported by opercular bones and (usually) branchiostegal rays, slender curved bones supporting the lower portion of the gill-cover. The skull is hyostylic, *i. e.* the jaw apparatus is linked to the auditory region of the skull by means of the hyomandibular bone. There is no cloaca and the rectum opens in front of the urinary and generative aperture or apertures. The ova are usually small and numerous.

STYLOPTERYGII (Fishes with Lobed Fins).

The Teleostome fishes are divided into three orders, the first two of which differ the one from the other chiefly in the characters of the paired fins. In the first order, the Stylopterygii, including the Crossopterygian Ganoids of older writers, the pectoral, and to a somewhat less extent the pelvic fins are 'lobed' like those of the

Dipnoi; they consist of a thick, muscular, scale-covered middle part, the lobe, either pointed or rounded at the end, and a fringe or marginal membrane supported by closely-set fin-rays developed in the skin (dermal fin-rays). The dorsal fins are two, or else (e. g. *Polypterus*, 193, and fig. 40) consist of numerous finlets; the pelvic fins are set well behind the pectorals (abdominal position).

The cartilage of the skull in the Stylopterygian fishes is well protected by dermal bones; there is no supraoccipital bone. There are two or more jugular plates between the halves of the mandible, and the branchiostegal rays have the form of lateral jugular plates. There are a pair of infraclavicles in the shoulder girdle. The known range of these fishes is from the Devonian epoch to the present time. In the sole living representatives of the order, *Polypterus* and *Calamichthys*, the heart has a conus arteriosus provided with numerous valves; there is a spiral valve in the intestine, the spiracles are open, abdominal pores are present, the air-bladder has an open duct, and the optic nerves meet below the brain in the form of a cross, or 'chiasma.' The principal suborders of the Stylopterygii are the Holoptychioides or Rhipidistia, the Cœlacanthoides or Actinistia, and the Polyteroides or Cladistia.

HOLOPTYCHIOIDES.

The Holoptychioides are extinct fishes, the remains of which occur mostly in rocks of Devonian and Carboniferous age. In the anal fin and in each of the two dorsal fins the most internal skeletal elements (axonosts) are fused into a single piece, with a broad outer bend, bearing from three to six rod-like elements (baseosts), which are fewer than the dermal fin-rays, and are overlapped by them. The skeleton of the pectoral fin articulates with the shoulder girdle by a single basal element (unibasal fin). The vertebral column has no ossified centra, or has ring-like centra. The teeth have a complicated folded structure; the nostrils are on the lower surface of the snout.

In the family Holoptychiidae, e. g. *Holoptychius flemingi* (186, and fig. 36), the remains of which fish occur in the Upper Old Red Sandstone of Scotland and the Upper Devonian of Belgium, the body is covered with overlapping cycloid

Holo-
ptychius.

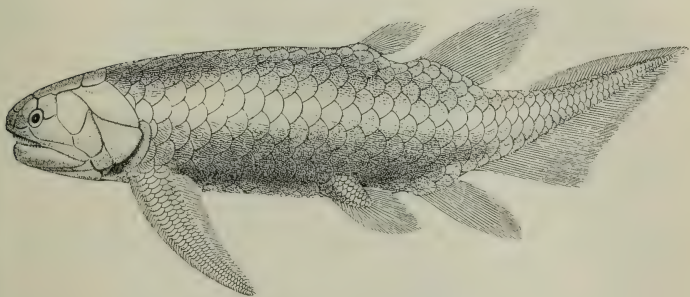


FIG. 36.—*Holoptychius flemingi*, restored.

scales with a superficial layer of hard substance resembling the enamel of teeth, and called vitro-dentine or ganoin. The pectoral fins have a long, pointed, scaled axis or lobe, the vertebral column has no bony centra, the axis of the tail is slightly up-tilted, and the vertical infoldings of the teeth are very numerous and complex.

In the family Rhizodontidae, represented in the exhibited series by *Eusthenopteron foordi* (188, and fig. 37), a fish found in the Upper Devonian of Canada, the scales are cycloid, like those of *Holoptychius*, the pectoral and pelvic fins are shorter than those of the Holoptychian fishes, the vertebral column has ring-like centra in some of the genera, the axis of the tail is either straight or is slightly up-tilted, the teeth are conical, and the vertical infoldings of the walls are comparatively simple.

Resembling the Rhizodontidae in the pectoral fins being obtusely lobate, but differing in the scales being rhomboidal instead of

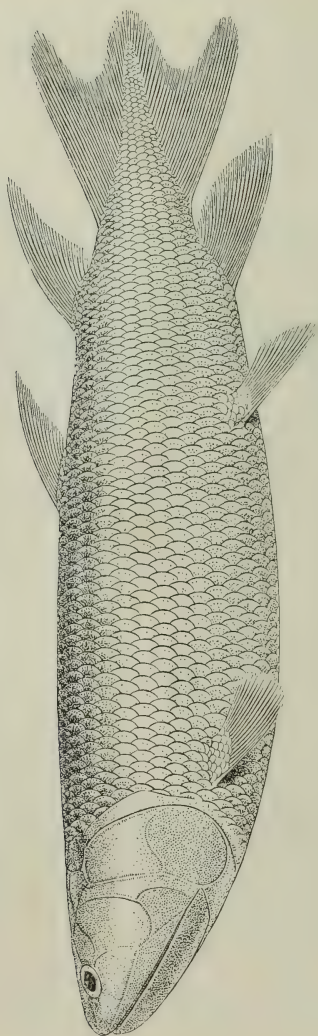
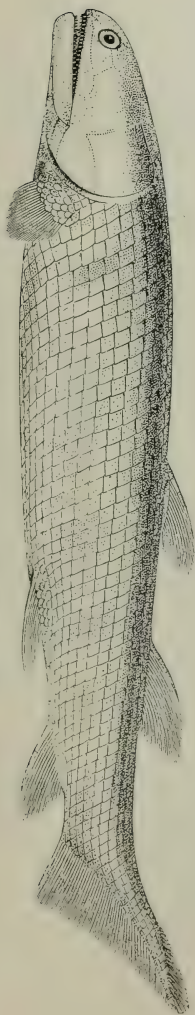


FIG. 37.--*Eusthenopteron foordi*, restored.

Osteo-
lepis.FIG. 38.—*Osteolepis macrolepidotus*, restored.

cycloid, and in having a more continuous and smooth layer of ganoin, are the Osteolepidæ, e. g. *Osteolepis macrolepidotus* (189, and fig. 38), a fish whose remains occur in the Lower Old Red Sandstone of Scotland, and *Megalichthys hibberti*, 190, a much larger fish from the Coal Measures of Great Britain. The vertebral column has ring-like centra in the caudal region; the vertebral axis of the tail is slightly uptilted, the teeth are conical, with the wall only slightly infolded at the base.

The four restorations alluded to in the preceding paragraphs, and several others exhibited in Wall-cases 5-7, have been constructed after critical examination of the remains of the fishes in the Geological Department of the Museum, and the published figures of other specimens, with a view to enabling the public visiting this Gallery to form some idea of what the fishes probably looked like in the ages long ago in which they lived. The size of the fish, the form of the body, whether rounded or flattened, the shape of the various fins, their positions on the body, the outline of the tail, the characters and arrangement of the scales and head-plates—these are details which may be gathered from the

restorations. The colours that have been given to the models are, of course, fanciful; the plaster models in their natural whiteness would have been painful to the eye, and although to leave them uncoloured would have been a more candid admission of ignorance as to what the real colours of the fishes were, the models would not have lent themselves well for comparison of their structural features with those of the stuffed fishes exhibited in the same cases.

CÆLACANTHOIDES.

The suborder Cœlacanthoides is represented by a restoration of *Undina gulo* (192, and fig. 39) from the Lower Lias of Dorset, and a cast of a specimen of *Undina penicillata*, 191, from the Lithographic Stone (Lower Kimmeridgian) of Bavaria. The range of the suborder in the present state of our knowledge is from the Lower Carboniferous to the Upper Cretaceous. The proximal skeletal elements, or axonosts, of the anal fin and of each of the dorsal fins are fused into a single piece. The paired fins are comparatively short (obtusely lobate), and the skeleton of the pectoral is unibasal. The vertebral column is without bony centra. In the tail fin above and below the vertebral axis the axonosts are equal in number to the neural and hæmal spines of the vertebræ, and each axonost is directly connected with a single dermal fin-ray. The outline of the tail is symmetrical, usually with an axial vestige of the dwindling caudal fin proper, showing that the "tail fin" is composed mainly of detached portions of the dorsal and anal fins. The distal parts of the dermal fin-rays of all the fins are transversely jointed, but they are not forked. The scales are cycloid, and the teeth are simple. The skeleton of the gill-cover is reduced to a single opercular bone. There is a bony wall to the air-bladder. The nostrils are on the under side of the snout. The principal genera are *Cœlacanthus* (Carboniferous and Permian of Britain and Germany), *Undina* (Jurassic), *Diplurus* (Trias of North America), and *Macropoma* (Cretaceous of England, &c.).

Undina.

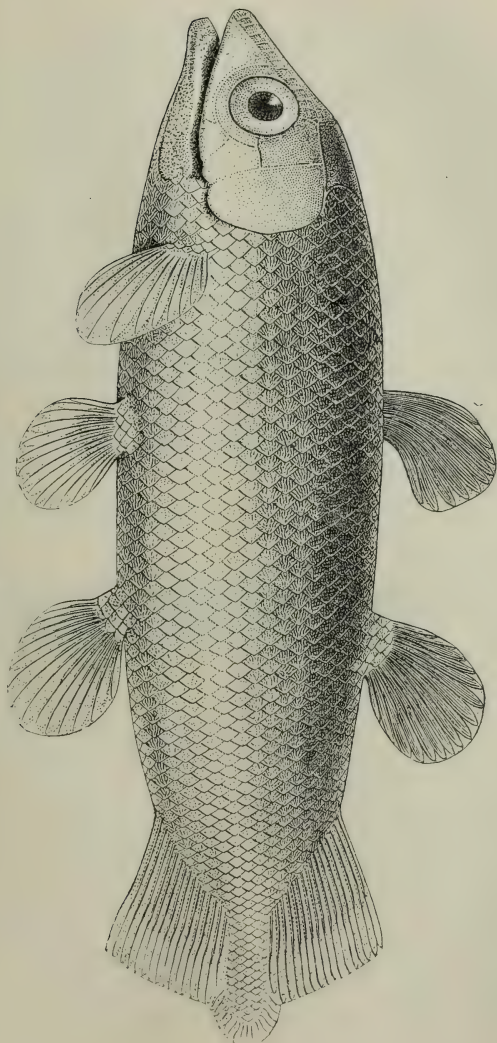
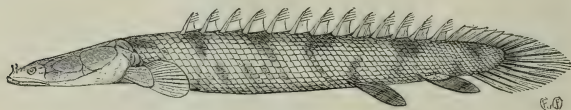


Fig. 39.—*Undina gulo*, restored.

POLYPTEROIDES.

Poly-
pterus.

The suborder Polypteroides includes the only modern Crossopterygian fishes, namely *Polypterus* (193, and fig. 40), and *Calamichthys* (195), fresh-water fishes of tropical Africa. The dorsal fin has the form of numerous finlets, each with a spine in front; the outline of the tail is symmetrical, and the axis is not uptilted in the adult, although it is in the young. The pectoral fins are obtusely lobate; the skeleton of each consists of three basal elements articulating with the shoulder girdle, a row of rod-like bones radiating from their periphery, and long, thin, closely-set dermal fin-rays supporting the marginal fringe of the fin; the pelvic fins are not lobate. The centra of the vertebræ are ossified, and are concave in front and behind (amphicœlous). The scales are rhombic, set in oblique lines, thick, with an external layer of smooth, hard vitro-dentine or ganoin, covered by soft skin. The teeth are simple, the walls not folded. There are two vomerine bones, and two jugular plates. The nostrils are on the upper side of the snout and project as short tubes; the spiracles remain open.

FIG. 40.—*Polypterus bichir*.

Polypterus (193), like the Lung-fishes, is capable of breathing air, but it cannot remain alive out of water more than three hours. The air-bladder is double and cellular, and its duct opens into the ventral wall of the pharynx. Its blood-supply is from the efferent vessel of the last gill; its vein joins the hepatic vein, and does not carry the blood direct to the heart as it does in the Dipnoi. The young *Polypterus* has an external gill, which is attached to the operculum (fig. 41). Ten or more species of *Polypterus* are known; the earliest known species is *Polypterus bichir* of the Nile, which is said to attain a length of four feet. It feeds on small fishes, frogs, and crustaceans. *Calamichthys* (195), is a

smaller and more attenuated and eel-like fish than *Polypterus*; it has no pelvic fins, and the dorsal finlets are more isolated, and each spine supports but a single soft ray. The fish lives in shallow parts of the Senegal and Congo among the interlaced roots of palms.

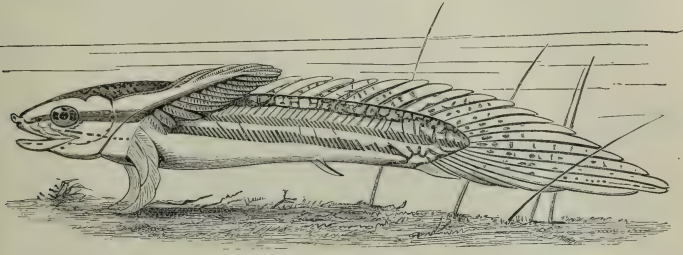


FIG. 41.—Larva of *Polypterus senegalensis*, $\times 4$, showing the large external gill. (From Bridge, Camb. Nat. Hist., vii, 1904, after Budgett.)

ASTYLOPTERYGII (Ganoid Fishes without Lobed Fins).

In the Astylopterygii the paired fins have not a conspicuous muscular "lobe." The projecting part of the fin consists of skin supported by large bony fin-rays of dermal origin, which articulate at their bases with a row of cartilages or bones, called the pterygia, embedded in the body and connected with the shoulder girdle (see skeleton of pectoral fin of Sturgeon, 209, and of Gar-pike, 217). The pelvic fins are set far behind the pectorals (abdominal position); the skull is well protected by dermal bones; there is no supraoccipital bone. The known range of these fishes is from the Devonian epoch to the present time. In the living representatives, *e. g.* the Sturgeon, Gar-pike and Bow-fin, the heart has a conus arteriosus provided with two or more rows of valves; there is a spiral valve in the intestine; abdominal pores are present; the air-bladder has an open duct; the testis is connected with the kidney; and the optic nerves meet below the brain in the form of a chiasma. There are three suborders, the Sturioniformes or Sturgeons, the Lepidosteiformes or Gar-pikes, and the Amiiformes or Bow-fins.

STURIONIFORMES (Sturgeons).

The Sturioniformes or Chondrostei are the fishes long known as the "Cartilaginous Ganoids." In the most ancient forms (e. g. *Palæoniscus*, 196, and fig. 42) the covering of the body consists of a continuous cuirass of rhombic scales, rarely of cycloid scales. In the modern forms the skin is almost devoid of scales, as in

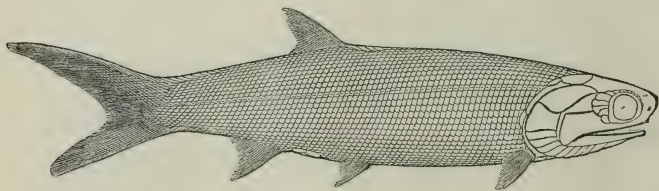


FIG. 42.—Restoration of *Palæoniscus macropomus*.
(After R. H. Traquair.)

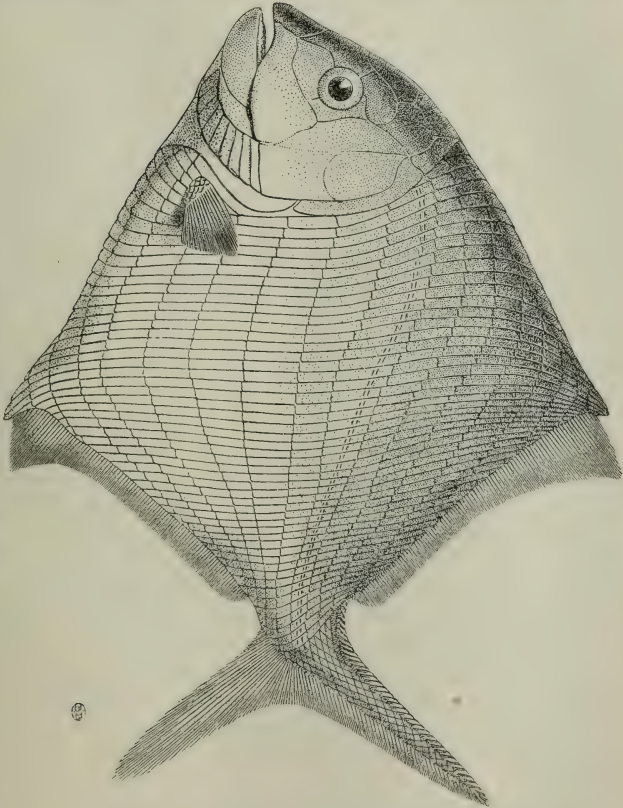
Polyodon, the Paddle-fish (211), or there are five longitudinal rows of keeled scutes, as in *Acipenser*, the Sturgeon (201). The endoskeleton is largely cartilaginous; the head is covered with bony plates of dermal origin; the notochord is persistent and not constricted by the formation of vertebral centra. There is a single dorsal fin and a single anal fin, with fulcra, *i. e.* spine-like scales along the front edge; the fin-rays of the median fins are more numerous than the basal elements; the caudal fin is usually heterocercal and with fulcra. The pelvic fins have a series of basal cartilages. An infraclavicle is present in the pectoral girdle, in addition to the clavicle and supraclavicle (see 208). The teeth are small or absent. The range of the suborder is from the Lower Devonian to the present time.

Palæ-
oniscus.

The Palæoniscidæ (196–197) are extinct fishes with elongate and fusiform body, with short-based dorsal and anal fins, and with a complete investment of rhombic scales, rarely with cycloid scales. The Palæoniscid fishes range from the Devonian to the Jurassic, and were most abundant in Carboniferous and Lower Permian times. *Cheirolepis* (197), is of Devonian age, and *Palæoniscus* (196) Upper Permian.

The Platysomatidæ (198) are extinct fishes ranging from the Carboniferous to the Permian. The body is laterally compressed and rather deep in a vertical direction, with a close investment of rhombic scales; the base of the dorsal fin is extended, the tail

FIG. 43.—*Cheirodus granulosus*, restored.



heterocercal. As in the previous family there are broad branchiostegal rays, with an anterior median plate in front. The jaws are short and stout, the teeth obtuse. The principal genera are *Cheirodus* (198, and fig. 43), *Eurynotus*, and *Platysomus*.

Cheirodus.

Chondrosteus.

The Chondrosteidæ (c. g. 200), which may be regarded as a connecting link between the ancient Palæoniscidæ and the modern Sturgeons, include *Chondrosteus*, from the Lower Lias of England, and *Gyrosteus*, from the Upper Lias of Yorkshire. There are no scutes in the skin, but the dorsal lobe of the tail-fin is armed with fulcra and clothed with rhombic scales. The mouth is small, situated on the under side of the snout, and without teeth in the adult. The eye is set far forward; there are numerous branchiostegal rays.

In the Polyodontidæ, a modern family including the Paddle-fish of the Mississippi valley (211), and the Sword-bill Sturgeon of the rivers of China (212), the scales in the skin are very small and isolated; the tail is heterocercal, and is armed with fulcra on the upper edge, the snout is much prolonged, and without barbels. The mouth is large, with minute teeth; the bones of the cranial roof form a discontinuous shield; there are no spines to the pectoral fins.

Paddle-fish.

The Paddle-fish or Spoon-bill Sturgeon, *Polyodon folium*, 211, is sluggish in its habits and feeds chiefly on the minute organisms contained in the mud which it consumes. The gill-rakers are long and fine, and form an efficient filter, preventing the food particles escaping through the gill-slits with the expiratory current of water. The paddle-shaped rostrum of the fish is used for stirring up the mud, and serves also as an organ of touch, necessary to the animal in consequence of the smallness of the eyes and the muddiness of the water which renders distinct vision impossible. The Paddle-fish reaches an occasional length of six feet and a weight of 120 lbs., but the average size is from 10 to 30 lbs. The Sword-bill Sturgeon, *Psephurus gladius*, 212, has a tapering rostrum, and the fulcra of the fins are fewer and of larger size than those of the Paddle-fish. The Sword-bill is said to attain a length of 20 feet; in its habits and mode of life it resembles the Paddle-fish.

Sword-bill.

In the Acipenseridæ, or Sturgeons proper, there are five longitudinal rows of keeled plates or scutes, and also small, irregular, stellate scutes scattered throughout the skin; the mouth is small, inferior, suctorial, and without teeth in the adult, and there are four barbels in front of the mouth. There are fulcra on the front

edge of the upper lobe of the tail fin, which is typically heterocercal. The first fin-ray of the pectoral fin is stout and spine-like. The gill-cover is supported by a single plate (opercular bone), and there are no branchiostegal rays. The bones of the cranial roof form a continuous shield, which has a median series of bones, not present in the Chondrosteidæ.

The fifteen or more species of Sturgeon (*Acipenser*) that are known occur in the seas, estuaries and rivers of the temperate and northern regions of the northern hemisphere. Most Sturgeons are migratory fishes, living in the sea, but ascending rivers for the purpose of spawning. Although the Sturgeons are not allied to the Salmon and are structurally very dissimilar, there is a strange parallelism in their habits and distribution; they are both anadromous, living in the sea but ascending rivers to spawn, and are both northern forms, common in Europe and North America, less common in Asia; in both there are some species or varieties which are non-migratory and confined to fresh water. Sturgeons are ground-feeders and root about diligently in the gravel, sand and mud for the worms, small fishes, molluscs and crustaceans that constitute their food. The mouth is very protrusible, and is thrust downward as a spout-like tube into the mud.

The Sturgeons are fishes of considerable economic importance. The flesh, though rich and fat, is esteemed as an article of food, and the ovaries of numerous Russian and American species find their way to market in the form of "caviare." The collection of the unshed spawn and its conversion into caviare form an important summer industry near the mouths of the great rivers of Eastern Europe. One of the most important stations is at Rubinsk, on the Volga, where the people collect in thousands in the late spring and await the advent of the fish in the river. As soon as notice is given by a look-out man of the arrival of the shoal, the people attack the fish by nets and spears. The ovaries are taken out, washed in vinegar, and spread upon boards in the open air. Salt is then rubbed in by hand and the caviare is pressed in bags and packed in kegs for the market. In Russia caviare is a regular article of diet, but in the western countries of Europe it is eaten only as a delicacy or a savoury. There is a superior form of caviare which is not salted and pressed, but is

Isinglass.

preserved on ice until it is required for consumption. From the air-bladder of the Sturgeon isinglass is prepared (see specimens 1185 in Cabinet-case 28). The air-bladders are slit open and cleaned and sent to market in the rough form, or the isinglass is extracted by hot water and dried in the form of thin sheets, which are sold as sheets, of various qualities, or are cut up into threads or rolled and bent into "staple." Specimens of all these kinds are shown.

The great Russian Sturgeon, *Acipenser huso*, that furnishes so much of the caviare and isinglass of commerce, is not at the time of writing this guide-book on exhibition in the museum. It grows to a weight of 3,000 lbs., and is found in the Black Sea, Caspian Sea, Sea of Azov and their rivers. The Sturgeon that is found off the British coast is *Acipenser sturio*, a species that is also caught in the Black Sea, the Mediterranean, the seas of Western and Northern Europe, and on the Atlantic coast of North America. It grows to 10 or 11 feet. The specimen 1136 hanging from the rail opposite Wall-case 6 was caught on the Dogger Bank in 1873, and measures 10 feet 4 inches; that marked 1102, standing within the centre rail, measures a little over 8 feet.

Acipenser sturio is commonly called the Royal Sturgeon, specimens caught in British waters being the property of the sovereign, although the royal prerogative is not exercised. In parts of the Continent where it is common this Sturgeon (*Acipenser sturio*) is utilised as a source of caviare and isinglass, as also are the Short-snouted Sturgeon, *Acipenser güldenstädtii*, 201, of the Danube and rivers and seas of Russia and Western Asia, and the *Acipenser stellatus* of Russia, 204, so called from the star-shaped ossifications in the skin. *Acipenser naccarii*, 205, is a Sturgeon confined to the Adriatic; it is known to the Italian fishermen as the "Storione cobice." *Acipenser maculosus*, 206, is the common Sturgeon of America; it is found on the coasts and in the rivers of Arctic and Eastern North America; *Acipenser rubicundus*, 202, is common in the great lakes of North America, and is called the Lake Sturgeon. The Sterlet, *Acipenser ruthenus*, 203, is a small Sturgeon, rarely exceeding three feet in length, found in the seas and rivers of Russia and also in the Danube; the flesh of the Sterlet is considered exceptionally choice.

The Shovel-nosed Sturgeon, *Scaphirhynchus platyrhynchus*, 210, of the Mississippi and other rivers of the Southern States of North America is confined to fresh water. It differs from the true Sturgeons of the genus *Acipenser* in the rostrum being long and flattened, in the absence of open spiracles, and in the union of the longitudinal rows of scutes beneath the dorsal fin to form a scaly armour investing the tail, whereas in the Sturgeons proper the rows of scutes remain distinct as far as the tail.

Shovel-
nose.

LEPIDOSTEIFORMES (Gar-pikes).

The Lepidosteiformes or *Ætheospondyli* are a small suborder including two families, the *Aspidorhynchidæ* and the *Lepidosteidæ*, the former with extinct fishes only. The body is covered with thick, rhombic scales, with a hard superficial layer of ganoin; they are arranged in oblique rows and are covered by a thin skin. All the fins have fulcra; the fin-rays are branched and jointed at their ends. The dorsal and anal fins are single and short-based, and their endoskeletal elements are as numerous as the dermal fin-rays. The pectoral fin has one row of basal bones (pterygia) carrying the dermal fin-rays*; the pelvic fins have not a series of basal cartilages. There is no infraclavicle in the pectoral girdle, and there is no pelvic girdle. The spiracle is wanting; the snout is elongated; in the mandible are splenial and coronoid bones; the vomerine bone is paired; there are no jugular plates; the opercular apparatus is complete; between the preopercular bone and the orbit are one or more rows of postorbital bones.

The *Aspidorhynchidæ* (213, and fig. 44, p. 78), are long-bodied fishes with a pointed preoral rostrum, and deep, rhomboidal, unequal scales. The fins are small, the fulcra weak; the caudal fin is homocercal, *i. e.* with symmetrical outline and without obvious uptilting of the vertebral axis. The vertebral centra are either

* The preparation marked 217 shows not merely the characters of the pectoral fin-skeleton of *Lepidosteus*, but may be taken to illustrate the distinctive features of the astylopterygian fin generally. The dermal fin-rays are strongly developed and form the most important part of the fin, while the basal parts of the skeleton, the pterygia, are reduced as compared with those of the stylopterygian fin, and are contained in a small muscular mound which projects but little from the side of the body.

ring-shaped or biconcave. The teeth are sharp; the lower jaw has a movable premandibular bone; the branchiostegal rays are numerous. These fishes range from the Lower Oolite to the Upper Chalk; there are two genera, *Aspidorhynchus* (213) and *Belonostomus*.

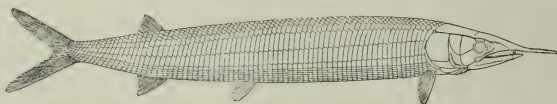


FIG. 44.—Restoration of *Aspidorhynchus acutirostris*.
(After A. S. Woodward.)

In the family Lepidosteidae the fin-fulcra are large; the tail has a fairly symmetrical outline although the vertebral axis is conspicuously uptilted; the centra of the vertebræ are well ossified and are convex in front and concave behind (opisthocœlous); the teeth are numerous, of unequal size, and the larger ones have the bases folded in a manner reminiscent of those of the Holoptychioides. The maxilla consists of several small bones in series; the branchiostegal rays are usually three. The conus arteriosus has eight longitudinal rows of valves, five in each row. Remains of species of *Lepidosteus* are known from Eocene and later strata.

Gar-pike.

The existing species of *Lepidosteus*, known as Gar-pikes (214–216, and fig. 45), inhabit the fresh waters of North America

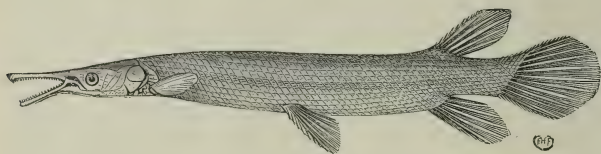


FIG. 45.—Broad-nosed Gar-Pike, *Lepidosteus viridis*.

and Cuba and one species occurs in China. The fishes are sluggish but voracious. They themselves are valueless as food, and they create havoc among other fresh-water fishes, against whose attacks they are invulnerable. Except in the breeding season the Gar-pike frequents the deeper parts of the rivers and lakes. The fish rises constantly to the surface, where it emits

bubbles of gas from the nostrils, situated near the end of the snout, in a manner suggesting that the air-bladder assists in the respiration.

AMIIFORMES (Bow-fins).

The Amiiformes or Protospondyli form a suborder of fishes all of which, except *Amia*, the Bow-fin of North America, are extinct, and most of which are Mesozoic in their stratigraphical range. The dermal fin-rays of the dorsal and anal fins are equal in number to the endoskeletal supporting elements; the endoskeletal elements of the pelvic fins are rudimentary or absent; there is no infraclavicle in the pectoral girdle. The extremity of the vertebral column is upturned, but the outline of the tail-fin is symmetrical. There is a median jugular plate between the halves of the mandible; the branchiostegal rays are flattened and rather broad; in the mandible are splenial and coronoid bones; there are two vomerine bones (coalescent in the Pycnodontidæ); there is no supraoccipital bone (except in *Dapedius*). The suborder comprises the families Semionotidæ, Macrosemiidæ, Pycnodontidæ, Eugnathidæ, Amiidæ, and Pachycormidæ.

Wall-
case 7.

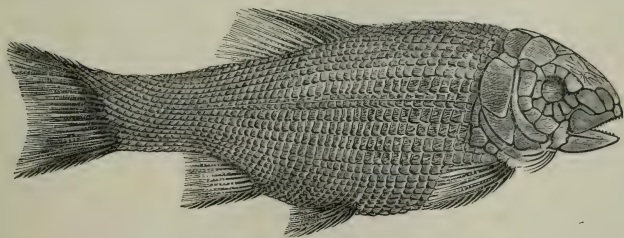


FIG. 46.—*Lepidotus mantelli*.

The Semionotidæ (fig. 46), the oldest and most generalised of the Amiiformes, are represented by *Lepidotus notopterus* (222), from the Lithographic Stone of Bavaria, the great *Lepidotus maximus* (1037, Table 49) from the same formation and locality, and a specimen of *Dapedius leiosomus* (223). In this family

Lepi-
dotus.

the body is somewhat compressed laterally and of moderate vertical depth, and is covered with rhombic scales; the dorsal fin does not extend more than half the length of the trunk; all the fins have large fulcra. The gape of the mouth is small, the jaws and vomer are provided with several rows of teeth, more or less conical. The vertebræ have either half-centra or ring-centra only, the notochord being evidently largely persistent in adult life. The parietal bones meet in the middle line. The range of the family is from the Upper Permian to the Cretaceous.

Pycno-
dontidæ.

In the family Pycnodontidæ also the body is compressed, high and oval, with rhombic scales, which, however, are in some cases wanting in the hinder part of the body. The pelvic fins are small, the dorsal and anal fins are more or less extended, and the fin-rays robust; there are no fulcra. There are no vertebral centra, the notochordal sheath being apparently without any ossifications. The opercular apparatus is reduced; there is no jugular plate; the parietal bones are separated by an occipital plate. The gape of the mouth is small, the dentition consists of prehensile teeth on the premaxillary and dentary bones, and oval teeth adapted for crushing on the vomerine and splenial bones (see 225). The family ranges from the Lower Lias to the Lower Eocene; the principal genera are *Gyrodus* (224, *Gyrodus circularis*, from the Lithographic Stone of Bavaria), *Mesturus*, *Mesodon* and *Pycnodus*.

The Eugnathidæ, e. g. *Eugnathus orthostomus*, 226, are a family of fishes which must have been predatory, judging from their large, strong mouth and their teeth, the marginal ones of which are conical and larger than the inner teeth. The body is long and not much laterally compressed, the scales are rhombic, the fulcra large, the fin-rays robust, the dorsal and anal fins short-based. The vertebral centra are rarely more than incomplete rings (hypocentra and pleurocentra alternating), two such rings to each vertebra. The opercular apparatus is complete, with a single jugular plate; the premaxillæ are in contact. The family ranges from the Trias to the Cretaceous.

Amiidæ

The family Amiidæ is a small one containing the living *Amia*, a fish which in structure approaches more nearly to the Neichthyes

or Teleostei than do any of the other fishes of the order Astylopterygii. The body is somewhat compressed laterally, and covered with thin, flexible, cycloid scales; the dorsal fin is more or less long and low, the anal fin is short-based; the fin-rays are robust; there are no fulcra, except in *Megalurus*. The tail is nearly homocercal, with a rounded hinder margin; it is distinctly heterocercal in the young. The vertebræ are well ossified (except in *Liodesmus*) and are amphicœlous (*i. e.* the centra are hollow both in front and behind); in the caudal region the half-centra remain distinct. The skull bears a close resemblance to that of the Teleostei, but the vomer is paired, and there is no supra-occipital bone. The opercular apparatus is complete, and there is a large median jugular plate. The premaxillary bones meet, and are not separated as they are in the next family.

The Bow-fin, *Amia calva*, 227, of the North American lakes and rivers, is the sole existing member of the family; it grows to about 30 inches in length; it is voracious and feeds upon crustaceans and insects. The general coloration is a dark mottled green; the male is smaller than the female and is distinguished by the presence of a round black spot encircled by a margin of orange at the base of the tail. The Bow-fin is valueless as food, the flesh being soft, watery and ill-flavoured. The air-bladder is cellular and lung-like, and opens into the dorsal wall of the pharynx. Owing to the high development of the air-bladder as a lung-sac the fish can live out of water for a long time. Bow-fin.

The Pachycormidæ (*e. g.* *Hypsocormus*, 229) are an extinct family of large-mouthed, predatory fishes related to the Amiidæ. The scales are thin and rhombic, sometimes rounded at the postero-inferior angle. The dorsal fin is short based, with fin-rays slender and closely set, and fulcra few or absent. The ethmoid region of the cranium is fused with the vomerine bones, and is more or less produced in front of the mouth, forming a prominent rostrum which separates the two premaxillæ. The branchiostegal rays are numerous; there is a single, large jugular plate. Some of the teeth are large and conical. Feeble ossifications sometimes occur in the sheath of the notochord, but in most cases the notochord persisted without reduction in Pachycormidæ.

adult life. The family ranges from the Lias to the Lower Cretaceous, and includes the genera *Pachycormus*, *Euthynotus*, *Hypsocormus*, and some others.

NEICHTHYES OR TELEOSTEI

("Modern" Bony Fishes).

The great majority of living fishes, fresh-water and marine, fall under the head Neichthyes or Teleostei. The skeleton of the paired fins consists almost entirely of ossified fin-rays of dermal origin, the row of ossified cartilages (pterygia) with which the basal ends of these are connected being very greatly reduced; except in the reduction of the pterygials the paired fins resemble those of the previous order, the Astylopterygii, and by some authorities the orders Astylopterygii and Neichthyes are grouped together under the same head, the Actinopterygii, characterised by the importance of the dermal fin-rays in comparison with the basal parts of the pectoral fin-skeleton. The muscles of the fin are confined to the basal parts, so that there is no "lobe" to the fin such as occurs in the order Stylopterygii.

The scales are thin, oval and overlapping; in a few cases they are absent, or exist in the form of hard scutes. Only in extinct transitional forms such as *Pholidophorus* are rhombic scales with superficial layer of ganoin present, and the same applies to the fulcrum of the fins. The skeleton is mainly bony; the vertebræ are distinct, and the centra are usually hollow in front and behind (amphicœlous). In most cases the hind end of the vertebral column is uptilted, although the outline of the tail fin is symmetrical (homocercal) with an abruptly truncated or forked hind edge. The vomerine bone is single, never paired; there is no splenial bone in the mandible and no exact equivalent to the coronoid bone of the Astylopterygii; there is a supraoccipital bone in the cranium. The infraclavicular bone of the shoulder-girdle is wanting.

The spiracle is closed. The heart has no conus arteriosus (except *Albula*); the intestine has no spiral valve (except *Chirocentrus*); the optic nerves cross one another beneath the brain and do not form an optic chiasma.

Physostomi.

The Teleostei or Neichthyes are divided into two main sections or "grades," the Physostomi and the Physoclisti. In the fishes of the grade Physostomi the air-bladder is usually present, and remains in open communication with the alimentary canal by a tube called the "pneumatic duct." The fishes are, on the whole, less specialised than those of the grade Physoclisti. Included in the Physostomi are the Salmoni-clupeiformes or Isospondyli—the Salmons, Herrings and allied fishes; the Cyprini-siluriformes or Ostariophysi—the Carps and Cat-fishes; the Anguilliformes or Apodes—the Eels; and the Esociformes or Haplomi—the Pikes and their allies.

SALMONI-CLUPEIFORMES (Salmons, Herrings, etc.).

The Salmoni-clupeiformes or Isospondyli are the most primitive of the Teleostei, and approach the Ganoid fishes (e. g. *Amia*) more closely than do other Teleosteans. The suborder includes the Tarpons, Herrings, Mormyrids, Osteoglossids, Salmons and Trouts. The anterior vertebræ are simple and not converted into a mechanical link-work for connecting the air-bladder with the ear as they are in the next suborder, the Cyprini-siluriformes. The maxillary bone forms usually part of the margin of the upper jaw; there are no barbels. The pelvic fins have many rays and are abdominal in position, *i. e.* are set some distance behind the pectoral fins. The shoulder-girdle is connected with the back of the cranium by the post-temporal bone, and has a mesocoracoid element (see girdle of Salmon, 277), a bone found in the pectoral girdle of all Ganoids, but among the Teleostei in the Salmoni-clupeiformes and the Cyprini-siluriformes only. None of the fins have spinous fin-rays.

The families Leptolepidæ (e. g. *Leptolepis dubius*, 232), Pholidophoridæ and Oligopleuridæ include small fishes which occupy a low position among the Neichthyes, and connect them with the Amioid fishes. These fishes are extinct, and their remains are found in Mesozoic strata. In all of them there is an aperture in the middle of each centrum through which passed the more or less

persistent notochord. In the Pholidophoridæ the scales are rhombic, in the other two families they are cycloid. The fins have fulcra in the Pholidophoridæ and Oligopleuridæ, but not in the Leptolepidæ.

Elopidae. Of the living Teleostean fishes the most primitive are the Elopidae. This family includes the Tarpon of Florida (*Megalops atlanticus*, 1110, Floor-case 27, and fig. 47), the Ox-eye (*Megalops cyprinoides*, 234), the Ten-pounder (*Elops saurus*, 233), and some extinct forms. The scales are not deciduous as they are in the Herrings (*Clupea*), the dorsal and anal fins are small, the former with short base and situated about the middle of the length of the body; the pectoral fins are set low down the sides of the body; the pelvic fins have 10–16 fin-rays. The mouth is wide and terminal, the teeth are minute and uniform in character. There is a single median jugular plate, a bone which occurs in no other living Teleostean fishes.



FIG. 47.—Tarpon, *Megalops atlanticus*.

(From Boulenger, Camb. Nat. Hist., vii, 1904, after Goode.)

Elops saurus (233) is a fish of wide distribution in tropical and sub-tropical seas, and very common in the open sea along the coast of southern United States, where it is known as the "Ten-pounder." The fish is not valued as food except by such people as the Hawaiians and Japanese who eat fishes raw. The young are delicate and ribbon-shaped, like those of the Lady-fish (*Albula*) and the Eel.

Megalops differs from *Elops* in having large scales (235), a large, short head, with oblique mouth of moderate size, and with a projecting lower jaw; the last ray of the dorsal fin is

produced into a long filament. The Tarpon (*Megalops atlanticus*, 1110, Floor-case 27, also fig. 47) is a littoral fish of warm American seas, and often enters rivers and even inland lakes. It is carnivorous, feeding on Mulletts and similar fishes, and grows to a length of seven feet or more and a weight of over 100 lbs. It disports itself noisily in the water, frequently leaping seven or eight feet out of the water and returning head first, with the body bent in the form of an arch, and with the gill-covers widely open displaying the red gills. The Tarpon ranks as the greatest of the game fishes and when hooked affords good sport; it is caught by rod and line from rowing boats. Tarpon.

The Ox-eye, *Megalops cyprinoides*, 234, differs from the Tarpon in being a less slender fish; the dorsal fin is not so far back and has more fin-rays (about 20), as also has the anal fin (about 25). Like the Tarpon it readily accommodates itself to fresh water. When the fishes are small, of about the size of Mackerel, they swim about in shoals, but when larger they are solitary. The Ox-eye rarely attains a length of five feet. It affords most excellent eating, in marked contrast with the Tarpon, and in some parts of India it is preserved in tanks or ponds for table use. Ox-eye.

The Albulidæ (*e. g.* the Lady-fish, 236) have a small mouth, with thick lips, and overhung by the bluntly-pointed snout. There are large crushing teeth in the inner parts of the mouth, and minute, pointed teeth on the bones of the jaws. As in the Elopidae the pectoral fins are set low down, the pelvic fins have 10-16 fin-rays; the tail fin is well-developed and forked, but the hæmal arches are more or less fused at the base of the tail, whereas in the Elopidae they remain separate. There are only two living genera, *Albula*, the Lady-fish, and *Bathyrhissa*, a deep-sea fish of Japan; remains of *Albula* (*Pisodus oweni*) occur in the London Clay of Sheppey.

The Lady-fish, *Albula conorhynchus*, 236, is a shore fish and subsists mainly upon bivalve molluscs, for the crushing of which its central dentition is well adapted. Full-grown specimens of the Lady-fish range from 20 to 30 inches in length, and from 3 to 10 lbs. in weight. Opinions differ as to the value of its flesh as food. The fish gives good sport to the angler when Lady-fish.

once it has been induced to take the bait, which is a live mussel or cockle left in a position where the fish may be expected to come. The young larval forms are band-shaped and transparent, and shrink considerably in size at the end of the larval stage of existence.

In Sharks, Lung-fishes, Sturgeons, Gar-pikes and Bow-fins there occurs in advance of the ventricle of the heart a small chamber called the "conus arteriosus," the walls of which are of striped muscle-fibre, like those of the ventricle, and the interior of which is provided with watch-pocket valves preventing the blood from passing back into the ventricle. In Teleostean fishes generally there is no conus arteriosus; the ventral aorta, however, is enlarged at its posterior end, where it comes off from the ventricle, and this part is known as the "bulbus arteriosus." Its walls are composed of elastic tissue and plain or unstriped muscle-fibre. In the heart of *Albula* there is a vestigial conus arteriosus, with striped muscle-fibres, and provided on the inside with two rows of valves, two large ones in the front row, and two large and two small in the second row. *Albula* is thus interesting as being a connecting link between the Teleostean fishes generally on the one hand and the Astylopterygian fishes, such as the Gar-pike and the Bow-fin, on the other.

Mormyridæ.

The Mormyridæ are fresh-water fishes of tropical Africa, of curious aspect, and very variable in the form of the head. The scales are small and cycloid; the mouth is often very small and in some cases (e.g. *Gnathonemus curvirostris*, 242) set at the end of an elongated snout; it is bounded above by the premaxillary bones, which are fused together. On each side of the cranium is a large vacuity occupied by a thick-walled air-vesicle, but in the dried skull having the form of a foramen leading into the cranial cavity and loosely covered by a large, thin lamina of bone, the supratemporal. The gill-opening is reduced to a small slit. The eyes are more or less reduced and are often indistinct beneath a thick, semi-transparent skin; the brain is large in proportion to the size of the body. In *Mormyrus* and *Gymnarchus* and some other genera a feeble electric organ occurs on each side of the tail, formed by a modification of the tail muscles into a

gelatinous substance enclosed in regularly arranged connective tissue compartments and supplied with enlarged spinal nerves. In all except *Gymnarchus* there are slender bones, known as Gemmingerian bones, occurring on each side of the tail, above and below the electric organ, the equivalents of which bones have not been recognised in any other fishes. The flesh of Mormyrid fishes is good, and one species, *Mormyrops deliciosus*, 241, derives its specific name from its excellent flavour. *Mormyrus oxyrhynchus* (238, and fig. 48) was venerated by the ancient Egyptians, and the outline of the fish appears frequently in their pictures. The long-snouted forms like *Gnathonemus curvirostris*, 242, search for their food in the mud and beneath stones, the finger-like process on the chin acting as a "feeler," the sensi-

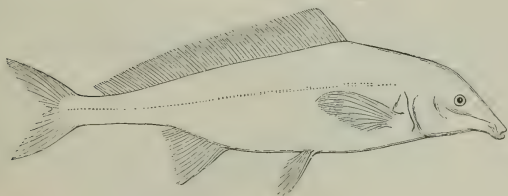


FIG. 48.—*Mormyrus oxyrhynchus*.
(From Günther, "Study of Fishes.")

tiveness of which compensates for the reduction in the power of distinct vision. The species with larger mouths seize small fishes and crustaceans. *Gymnarchus niloticus*, 243, of the Nile and rivers of West Africa, has a long, eel-like body, without caudal, anal, and pelvic fins. The dorsal fin extends the whole length of the body. The jaws have well-developed, chisel-edged teeth. The air-bladder is cellular and very extensible, and is an important organ of respiration. *Gymnarchus* moves through the water by the action of its dorsal fin only; it can move backwards as readily as forwards, and when retreating uses its tapering tail as a feeler. The fish makes a floating nest, which the male guards jealously; the young have external gill-filaments and

a large, pendulous yolk-sac (see 1162, Cabinet-case 29, and fig. 49).

Moon-
eye.

The Moon-eye, *Hyodon tergisus*, 244, of the fresh waters of North America east of the Rocky Mountains, constitutes a special family by itself, the Hyodontidæ. It is a silvery fish about 12 to 18 inches long, with a large mouth with strong, sharp teeth, and some particularly large teeth on the tongue. There are teeth on the parasphenoid bone, a primitive feature which is common to this fish and *Elops*, *Megalops*, *Albula*, *Arapaima*, *Osteoglossum*, *Notopterus*, and most Mormyridæ, but which occurs in no other living Teleostean fishes.

Notop-
terus.

The species of *Notopterus*, constituting the family Notopteridæ, are strange-looking fishes with a much compressed body, a short-

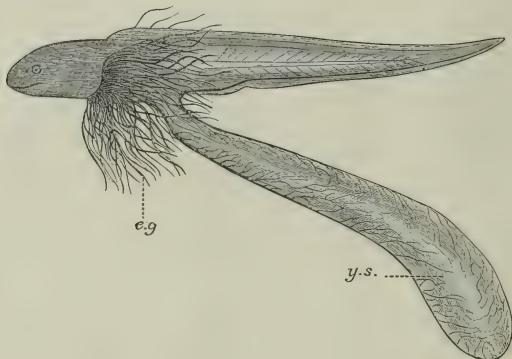


FIG. 49.—Young *Gymnarchus niloticus*, showing the large yolk-sac (y.s.) and the long external gills (e.g.).

(From Bridge, Camb. Nat. Hist., vii, 1904, after Budgett.)

based dorsal fin and a very extensive anal fin, which is continuous with the caudal fin. They are fresh-water or brackish-water fishes found in the marshes and lakes of Africa, India and the Malay Peninsula, and feeding on worms and insects. One of the largest species is *Notopterus chitala* of India (245), which grows to three or four feet in length; another well-known species is *Notopterus kaporat* (246), also from India and the Malay district. The scales are thin and cycloid, and extend over the

head and gill-covers. The pelvic fins are reduced or absent. The air-bladder is large and complex in structure ; it is connected with the ear by forwardly directed processes which enlarge at their ends into air-vesicles embedded in the side of the hinder part of the cranium, and it sends also a pair of processes back into the tail region.

The Osteoglossidæ are a sharply delimited family distinguished by the sculpturing of the superficial bones of the skull, the robust character of the cheek-plates, the meeting of the parietal bones, the sutural union of the nasal bones with one another and with the anterior ends of the frontal bones, and the presence of a stout, peg-like process of the parasphenoid for articulation with the entopterygoid. The scales are large and thick, and with a mosaic-like structure. The dorsal and anal fins are set back, and their bases are more or less extended. The trunk vertebræ have stout transverse processes for the attachment of the ribs (see

Osteo-
glossidæ.

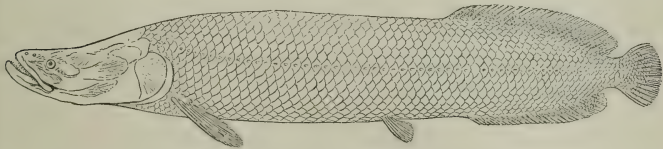


FIG. 50.—*Arapaima gigas*.

(From Boulenger, Camb. Nat. Hist., vii, 1904.)

skeleton of *Arapaima*, 1035, Table-case 50). The Osteoglossidæ are fresh-water fishes of the tropics. The *Arapaima* (*Arapaima gigas*, fig. 50, 1033 and 1034, Table-case 51, and skeleton, 1035, Table-case 50), locally known as the "Pirarucu," is a great fish of the rivers of Brazil and the Guianas, attaining a length of 15 feet and a weight of 400 lbs. or more. The larger specimen in Table-case 51 is a little under 8 feet in length. The scales are large (250, Wall-case 7), and in the living fish are greenish-brown, with a reddish hind border. The *Arapaima* is highly esteemed as an article of food ; the flesh is cured and salted in a manner similar to that of Cod-fish, and is an important article of local commerce. In the floor of the mouth of the fish is a bone covered with small teeth of uniform size (249) which the natives use as a rasp for scraping into a pulp the flesh of gourds and similar vegetables.

Osteoglossum and *Scleropages* are closely allied genera, the latter with a longer body and with more extended dorsal and anal fins than the former; in both the mouth-cleft as seen from the side is long and oblique, and the lower jaw is prominent and bears a pair of barbels. *Scleropages leichardti* (247) is the "Barramunda" of the Rivers of Queensland, although the name is indiscriminately used for this fish and the *Ceratodus* (171, Wall-case 6). Another species of *Scleropages* occurs in Sumatra and Borneo; *Osteoglossum* occurs in Brazil and the Guianas.

Heterotis (248) is a small-mouthed fish common in the Nile, Gambia and other rivers of tropical Africa. The air-bladder is cellular and probably is used as a breathing organ, and there is an accessory respiratory organ, spirally coiled, above the fourth gill arch. During the breeding season the fish constructs a large nest in a part of the swamp where the depth is about two feet, and here it rears the young, which at one period of their development breathe by external gill-filaments.

Clupeidæ.

The Clupeidæ are an important family of fishes including the Herrings, Shads and Anchovies; they are principally coast fishes, widely spread in the temperate and tropical zones, and some of them entering fresh waters communicating with the sea. The dorsal fin is small and set nearly in the middle of the back; there is no adipose dorsal fin. The scales are thin and readily shed; the gill-opening is usually very wide, and the opercular apparatus is complete. The parietal bones are separated by the supra-occipital; in most cases the maxilla assists the premaxilla in bounding the upper border of the gape; the teeth are feeble (except *Chirocentrus*), and two surmaxillary bones are usually present. The postclavicle is applied to the outer side of the clavicular bone, and not to the inner side as in the Salmonidæ. The pelvic fins have 6-11 fin-rays. The stomach is produced back into a blind sac; the air bladder in some cases (*e. g.* Herring) opens directly to the exterior in the vicinity of the anus. Inter-muscular bones are numerous; the ribs are mostly sessile, being inserted behind the transverse processes. The family is well represented in Cretaceous and Tertiary strata.

Dorab.

The Dorab, *Chirocentrus dorab*, 253, common in the Indian and Western Pacific Oceans, is a brilliantly silvery fish growing to

three feet in length, with a long, strongly compressed body and a saw-like edge on the belly. The dorsal fin is short-based and opposite to the anal, which is long. One of the most interesting features of *Chirocentrus* is the presence of a spiral valve in the intestine; such a valve is present in all Ganoid fishes, and the occurrence of the valve, even in a reduced form, in this Teleostean fish is of interest as pointing to the relationship between the lower Teleostean fishes and the Ganoids. *Portheus*, *Ichthyodectes* and *Saurodon* are Cretaceous fishes allied to *Chirocentrus*, but of much greater size and with the teeth lodged in sockets; by some authorities these fishes are placed in a separate family, the Saurodontidæ.

Included within the genus *Clupea* are the Herring, Pilchard, Sprat and Shad, fishes of northern distribution, with deciduous scales, a row of ridge-scales extending along the lower edge of the body from the shoulder girdle to the anal fin, a forked tail, a feeble dentition, and no lateral line. Most of the species are food fishes, but some of the tropical species are poisonous. The Herring, *Clupea harengus*, 255, is found on both European and American sides of the North Atlantic, and is especially abundant in the North Sea and off Norway. It may thus be regarded as a northern and a cold water fish. The "Herring" of the North Pacific is of another species, *Clupea pallasii*. The Herring fisheries of the North Sea take place during the spawning season, which reaches its height in June off Shetland, and in November off Lowestoft. The fishing fleets move southwards as the centre of shoaling shifts from point to point. The spawn of the Herring, unlike that of most other food fishes, even the allied Pilchard and Sprat, sinks to the bottom; but the fish are mostly caught near the surface in drift-nets, which may be more than a mile in length for each boat. About 8,000,000 cwts. of Herrings, valued at more than £2,000,000, are annually landed in Great Britain. The largest Herrings come from Loch Fyne, in Scotland.

The little fishes that go by the name of Whitebait consist of the fry of Herrings and Sprats, both of which have a predilection for brackish water. The Thames Whitebait consists chiefly of

Herring.

White-
bait.

young Sprats during the winter and young Herrings during the summer.

Pilchard. The Pilchard, *Clupea pilchardus*, 263, unlike the Herring, is a warm water fish, distributed from Cornwall and the South of Ireland to Madeira and the Mediterranean. It is taken in drift-nets and seines, and is fished for near the coast during the feeding migrations, and not when spawning. The fishery fluctuates greatly, but the Cornish take is rarely less than 100,000 cwts. per annum, valued at £30,000. The Pilchard is smaller than the Herring and may be distinguished by its having well-marked radiating ridges on the gill-cover; another test common among the Cornish fishermen is practised by holding the fish by the tip of its dorsal fin: the Pilchard's body hangs horizontally, but that of the Herring dips slightly down at the head end, since the dorsal fin is set a little farther back in that fish than in the Pilchard. The fishes known as Sardines are young Pilchards. The Sardine fishery of the West coast of France is a valuable one, but is subject to great fluctuations, and a scarcity of the fish has at times given rise to a critical situation on the French coast.

Sprat. The Sprat, *Clupea sprattus*, 264, is a small species of *Clupea*, generally distributed around the British Isles and the coasts of continental Europe. It may be distinguished from young Herrings by having no teeth on the vomerine bone, and by having only a single air-vesicle in the ear instead of two; careful dissection is required for the application of this latter test, but it is the most reliable one that can be adopted in discriminating between Sprat Whitebait and Herring Whitebait.

Shad. Of the Shads, two are caught on the coasts and in the estuaries of Britain, the Allis Shad, *Clupea alosa*, 256, and the Thwaite Shad, *Clupea finta*, 257; there is no regular fishery for Shad in British waters as there is in the Rhine and some of the other large rivers of continental Europe. The average size of the Allis Shad is that of the specimen exhibited (3 lbs.), the Thwaite Shad is usually smaller. The Thwaite and Allis may be distinguished by the former having 21-27 stout, rigid gill-rakers on the first gill arch and the latter 60-80 very fine, long and flexible gill-rakers on the first arch (259 and 258).

The American Shad (*Clupea sapidissima*) is closely allied to our own Shads, and its flesh is said to be superior in flavour. The United States Fisheries Commission has achieved great success in its efforts to propagate the Shad in nurseries and to liberate the little fishes on hatching, with the result that the Shad is now declared to be one of the best and cheapest fishes in the American market. The Commission has also been successful in transplanting the Shad from the Atlantic coast of North America to the Pacific coast, in the waters of which it did not previously exist, and where it now abounds from Puget Sound southwards to Point Concepcion, ascending the rivers to spawn in May as it does on its native coast. In consequence of the attention that has been bestowed upon it, the *Clupea sapidissima* is commonly dubbed the "Commission Shad."

Another important American fish is the Menhaden or Moss-banker, *Clupea menhaden*, common on the Atlantic coast of the United States. It is a coarse and bony fish, rarely eaten when adult, but valuable on account of the rich oil which it yields in abundance; the refuse after the oil has been extracted from the fish is used as a manure for the corn-fields; the fresh fish is largely used as bait.

Hyperlophus (270) is a genus of fishes found at the present day in the rivers and on the coasts of Chili and New South Wales, and occurring in a fossil state in the Upper Cretaceous rocks of Syria, Southern Europe and South America, and in the Eocene shales of the Green River, Wyoming. It is distinguished from the genus *Clupea* by having not only a row of ventral ridge-scales, but a row of dorsal ridge-scales extending from the back of the head to the dorsal fin.

The Hickory-Shad, *Chatoëssus* or *Dorosoma*, 267, is a deep-bodied fish of the rivers and estuaries of Eastern America, Eastern Asia, and Australia, with small, toothless mouth, a reduced maxillary bone, and a suprabranchial accessory organ of respiration over the fourth gill arch. The stomach is muscular and thickened, and has the form of a hickory nut, whence the name Hickory-shad given to these fishes by the Americans; the name is applied in particular to the species *C. cepedianum* of the rivers and estuaries of the Eastern United States. The belly is serrated,

the last ray of the dorsal fin prolonged and whip-like, the gill-rakers are fine and form a strainer for the mud in which these fishes find their food.

Anchovy. The Anchovy, *Engraulis encrasicolus*, 268, has no ridge-scales; the body scales are large, there is no lateral line, the snout is conical and projects beyond the front of the lower jaw, the mouth cleft is large, the maxillary bone long and slender, and the premaxillary small. The European Anchovy is largely preserved either in oil or packed in small barrels with salt, bay-leaves and spices, or the flesh is made into a paste or sauce for use as a relish with other fish served as food. The Anchovy is especially abundant in the Mediterranean, but occurs also in numbers in the Zuyder Zee and other parts of Holland; it does not occur regularly in British waters.

Coilia nasus, 269, a fish of the Indian and China Seas, is allied to the Anchovy; it is of larger size and has a long tapering tail and a long-based anal fin continued on to the tail. Two or three of the uppermost fin-rays of the pectoral fin are prolonged and freely branched, and there is a remarkable backward extension of the maxilla which is toothed for its whole length in spite of the fact that only the anterior portion of that bone engages with the lower jaw.

Milk-fish. The Milk-fish, *Chanos salmoneus*, 266, departs from the typical Clupeoids in the reduction in the size of the mouth, the absence of teeth in the jaws, and a number of other features of the skull. The tail fin is deeply forked and has a scaly lamella at the base of each lobe; there is a distinct lateral line, and an accessory branchial organ behind and above the gills. The fish is very swift in the water, and grows to about 4 feet in length. It is abundant in the Gulf of California, the Indian Ocean and Polynesian seas; it is largely used as food in Hawaii, where it is known as the "Awa."

Salmon-
idæ. The Salmonidæ are an important family of fishes having a small adipose fin, a thick, fat-laden fin without fin-rays, between the dorsal fin and the tail. The pectoral fins are inserted low down the sides of the body, the post-clavicular bone is applied to the inner side of the clavicle; there are no barbels, the margin of the upper jaw is supported by both the premaxillary and the maxillary

bones, and there is a single surmaxilla. Most of the fresh-water forms are peculiar to the temperate and arctic regions of the northern hemisphere, but one (*Retropinna*) occurs in New Zealand; most of the purely marine forms are from the deep sea. Many species are anadromous in habit, *i. e.* living in the sea, but entering fresh water to spawn and descending again to the sea afterwards.

The genus *Salmo* is one of great interest, not only because of the value of the fishes of the genus for purposes of food and the sport which their capture affords, but because of their plasticity and ready response to altered conditions of life. As a rule the fresh-water forms are brown and the marine forms bright and silvery, and the change from the one colour to the other may, in the migratory forms, be observed in the same individual at different periods of its life. In the non-migratory forms the colours are fairly constant while the fish remains in the same waters, but by transferring to new localities brown forms may become silvery and silvery ones brown. If the colouring of the body be disregarded the British species of *Salmo* may be counted as three in number:—*Salmo salar*, the Salmon and its varieties, *Salmo trutta*, including all the Trouts, such as Salmon Trout, Bull Trout, Great Lake Trout, Brook Trout, and *Salmo alpinus*, including all the Charrs. For fuller details of the varieties the visitor is referred to the series exhibited in Cabinet-case 43, and to the specimens in the Wall-case in the British Collection at the West end of the Bird Gallery.

The true Salmon, *Salmo salar*, 276, is confined to the northern hemisphere between latitudes 75° and 41° or 43° N.; it occurs in America and Asia as well as in Europe, and does not exist in the Mediterranean and the rivers flowing into it. In Britain the Salmon comes up from the sea into fresh water usually from September or October to January. The nest or redd is dug in the gravel by the female, and after being fertilised by the male, the eggs are buried. The newly hatched fry, or Alevins (272), become free about 90 days after the eggs are laid; they grow to 4 or 6 inches in length, when they are known as Parr or Pink (273); the body is marked by vertical blue bars and large spots and is not silvery. The fish either in the first year, or more usually in the second year, lose the parr marks, and become Smolts

Salmon.

(274) and commence their descent to the sea. They are then about 8 inches long and silvery in colour. On its first return from the sea the fish is known as a Grilse (275) or Salmon Peal; such a fish would weigh 3 lbs. if caught in the river in June, but a Grilse that had delayed its return to fresh water till the end of July would weigh 9 or 10 lbs. if in good condition. The term "Salmon" is only applied to a fish on its second and subsequent ascents. A Kelt is a spent Salmon, one which has spawned and is returning to the sea. A Kipper is a lean Salmon which has failed to descend to the sea after spawning. In mature male Salmon the upper and lower jaws become enlarged at the front and bent over, the lower jaw being particularly hooked, and giving a sinister appearance to the head.

The Salmon only comes up the rivers to spawn; it does not feed in fresh water, judging by the absence of food-material in the stomachs of fishes examined, and it is this circumstance which renders so unaccountable the fatal fascination exercised by that wonderful tuft of feathers and coloured wool which anglers term the "fly". The pink colour of the flesh of the Salmon is attributed to its feeding on crustaceans such as shrimps and prawns.

The excellence of the Salmon as a food fish has rendered Salmon-fisheries the object of constant attention on the part of the legislature from the earliest times of which we have any record. The fisheries form an exceedingly valuable part of the natural wealth of the country. In Scotland the rateable value of the Salmon-fisheries in those districts where Fishery Boards have been formed was assessed in the year 1898 at over £107,000. The Salmon carried to market by the railways and steamers of Scotland amounted to 4,230 tons in 1895 and to 2,093 tons in 1898. The heaviest British Salmon on authentic record is one taken in the Tay which weighed 70 lbs. It must be borne in mind, however, that some of the large fish which the Tay anglers call Salmon are really Bull Trout, and the 70 lb. fish may have been such a fish. In the British Pavilion, at the end of the Bird Gallery, is exhibited a Bull Trout from the Tay weighing 55 lbs.

The Salmon 276 in Wall-case 7 of this Gallery weighed 33 lbs. when caught; it was taken in the Tay at Perth in July.

The Sea Trout or Salmon Trout, 279, a migratory form of *Salmo trutta* coming up from the sea into fresh water to spawn, is a coarser fish than the Salmon (*Salmo salar*) ; the flesh is not so pink, is of drier texture, and is less richly flavoured. Large specimens of the Sea Trout are known as Bull Trout. The Sea Trout may be distinguished from the Salmon by its smaller and more numerous scales, there being 14 to 16 scales in a line passing downward and forward from the hind edge of the base of the adipose fin as far as the lateral line, not counting the lateral line scale, whereas in the Salmon the number is 11 or 12. The root of the tail is stouter and of more clumsy appearance in a Sea Trout than in a Salmon, and the hind border of the tail fin changes from the concave to the flat, and ultimately to the slightly convex shape, earlier in the Trout than in the Salmon. The anal fin is larger and set farther back, and the anterior fin-rays relatively longer than in the Salmon. The gill-cover has the hind edge more angulate and less semicircular than in the Salmon, and has usually more spots upon it. The side of the body has more black spots below the lateral line than that of the Salmon. When the mouth is closed the hind end of the upper jaw (maxilla) is farther back than in the Salmon, and the first branchial arch has 17 or 18 gill-rakers, whereas that of the Salmon has usually 20. The breeding habits of the Sea Trout are much the same as those of the Salmon ; the Smolts are readily distinguishable from Salmon Smolts by having yellow pectoral fins. The Grilse of the Sea Trout is known as Pinok.

Sea
Trout.

The Brook Trout or Brown Trout (280), the variety *fario* of the species *Salmo trutta*, is a form which is confined to fresh water, and lives in brooks, streams and ponds of European countries. In Britain it does not run much over 10 lbs. in weight ; in the river Thames in the year 1907 Trout of 8 lbs. were caught on three occasions ; in the same year a Trout was caught in the New River weighing 18 lbs., but fish of this size are very exceptional.

Brook
Trout.

Salmo alpinus includes the Charrs of Britain, varieties of which from Buttermere, Windermere, and Sutherland are shown in Cabinet-case 43. The Swiss Charr, 284, the "Omble chevalier" of the Swiss lakes, is a red Charr of the variety *umbla*. The

Charr.

American Charr, *Salmo fontinalis*, 281, which the Americans call their "Brook Trout," has been introduced with success into Britain, as also has the Rainbow Trout, *Salmo irideus*, 282, but the colours of the acclimatised Rainbow Trout are not so brilliant as those of the fishes in their native mountain streams in the Rocky Mountains.

The Namaycush or Lake Trout of North America, *Salmo (Cristivomer) namaycush*, 285, is a non-migratory Trout, with deeply-forked tail fin and strong teeth, inhabiting all the Great Lakes of the northern part of North America. The fish is grey, not brown as are most non-migratory Trout; it is a sluggish, heavy-looking, ravenous fish, attaining an average weight of 15 to 20 lbs. The North Pacific Salmon or Quinnot Salmon (1099, near Table 25), has more fin-rays in the anal fin than our *Salmo*, and is placed in a separate genus, *Onchorhynchus*. It is migratory, and similar in habits to our Salmon and Sea Trout. A large proportion of the tinned Salmon that is sold in England is the flesh of the Quinnot Salmon of British Columbia and Alaska. The average weight of the fish is 22 lbs., but individuals of 70 to 100 lbs. are occasionally taken.

The genus *Coregonus* includes the various White-fish, fishes of the northern parts of temperate Europe, Asia, and North America,

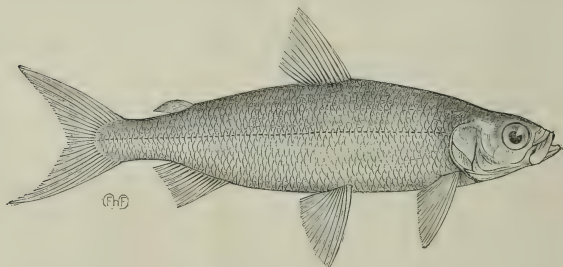


FIG. 51.—Vendace, *Coregonus vandesius*.

and mostly lacustrine and rigidly localised, although a few are anadromous in habit. The mouth is smaller and shorter than that of *Salmo*, the maxillary bone not extending back below the

eye; the teeth are minute or wanting; the tail fin is deeply forked; the scales are moderately large, and the ova are small. The commoner species are *Coregonus oxyrhynchus* (291), the Houting of the seas and rivers of Holland, Germany, and Denmark; *Coregonus vandesius*, the Vendace (287, fig. 51), of fresh-water lochs of Scotland, particularly Loch Maben; *Coregonus pollan* (288), the Pollan, of the fresh waters of Ireland, particularly Lough Neagh, where at certain seasons of the year it used to be an important marketable fish; and *Coregonus clupeoides*, the Gwyniad, 290, of Wales, the Lake District and Loch Lomond. The name Gwyniad is usually restricted to the variety of *Coregonus clupeoides* that occurs in Lake Bala in North Wales. The variety found in Loch Lomond is called the Powan, and that of Haweswater and Ullswater the Schelly or Skelly. The "Fera" of the Swiss Lakes (289) is represented in Bavaria, North Prussia and Sweden by varieties which are known respectively as Bodenrenke, Maräne and Sik. *Coregonus clupeiformis* (*Argyrosomus artedi* of the Americans), 286, is the well-known Lake Herring or Cisco of the great Lakes Erie and Ontario of North America.

Pollan
and
Gwyniad.

The Grayling, *Thymallus vulgaris*, 293, of the clear streams and lakes of Central and Northern Europe is distinguished by its high dorsal fin, which is supported by about twenty fin-rays, the most anterior ones of which are simple and unbranched. The fish derives its generic name from its emitting an odour resembling that of thyme. The Grayling breeds in April and May, whereas Salmon and Trout breed in October to January, and it thus affords sport during the close time for the usual Salmonoids. In English streams it grows commonly to 2 or 3 lbs. in weight. *Thymallus vulgaris* is confined to Europe, but there are other species, one, known as the "Poisson bleu," in Canada.

The Argentines are deep-sea Salmonoids found in the Mediterranean, the Arctic and North Atlantic Oceans. The common Mediterranean species is *Argentina sphyraena*; a northern form, *Argentina hebridica* (295), found off the North of Ireland, Scotland, and more particularly off Norway, finds its way occasionally to the English markets. The Argentines are sometimes called Siel-Smelts.

Smelt. The Smelt, *Osmerus eperlanus*, 294, is a delicate, semitransparent fish, which emits a peculiar and not unpleasant odour. In habits it is gregarious, and it is essentially estuarine, at least in Great Britain, and frequents only those rivers which enter the sea through long winding channels in extensive mud flats. The Smelt rarely exceeds nine inches in length; as a delicate table fish it takes high rank.

The Candle-fish, *Thaleichthys pacificus*, 296, a fish about nine inches in length, ascends the Columbia River, Fraser River, and streams of Southern Alaska in the spring in immense numbers for the purpose of spawning. Its flesh is white and of excellent flavour. It is so charged with oil that the dried fish, with a cotton wick drawn through the body, will burn like a candle. The local name is Eulachon or Oolachan.

Capelin. The Capelin, *Mallotus villosus*, 292, is a fish of the coasts of Arctic America and Kamtschatka, six to nine inches in length, with large paired fins, a feeble dentition, a prominent mandible, and with small scales, four longitudinal bands of which become greatly produced in the males and cause the body to look shaggy, whence the specific name *villosus*.

Salanx (297) is a small, slender, transparent, whitish little fish, two to seven inches in length, which lives at a considerable depth in the sea, and ascends the rivers of China and Japan at certain seasons to spawn. The fish is called Ice-fish on account of its transparency. The "Whitebait" of Canton consists of *Salanx chinensis*, and is considered a great delicacy.

Alepocephalus. The Alepocephalidæ constitute a characteristic family of deep-sea fishes having affinities with the Salmonidæ and the Clupeidæ. They are of remarkable appearance and wide distribution, occurring between the depths of 300 and 2,000 fathoms in many parts of the world. The dorsal fin is set far back and there is no adipose fin. *Alepocephalus rostratus* (298) of the Mediterranean has cycloid scales, but scales are wanting in some of the genera. *Aulostomatomorpha* (984, Cabinet-case 44) of the Indian Ocean has the snout much produced, and a uniformly luminous head. The skeleton of these fishes is feebly ossified.

Stomias. The Stomiidæ are aberrant, deep-sea fishes, readily distinguishable from other deep-sea fishes by having the maxilla

longer than the premaxilla, and beset with teeth. Scales are absent or are exceedingly delicate; luminous spots, regularly arranged, are present in most of the species. The eyes are large, a hyoid barbel is frequently present, the gill-opening is wide, the opercular skeleton reduced. An adipose fin is present in some genera. The fishes are predatory and some have a formidable dentition. The chief genera are *Stomias* (299), *Malacosteus* (fig. 5, 979, Deep-sea Series, Cabinet-case 44), *Chauliodus* (fig. 8, 975, Cabinet-case 44) and *Sternoptyx*, the last two being by some authorities placed in a special family, the Sternoptychidæ. Within the family Stomiatidæ examples occur of the reduction of the pectoral fins before the pelvic; in cases in which the paired fins undergo reduction it is almost always the pelvic fins which disappear first, *e.g.* among the Eels, Sand-launces, Blennies and Scabbard-fishes.

The Gonorhynchidæ (300) are aberrant fishes, the affinities of which are not definitely known; they have been associated by various authors with the Cyprinoids, the Scopeloids, and the Salmonoids. The body is long and cylindrical, without adipose fin. The scales are narrow, small and with spiny edge, deeply imbricated, and extending over the cheeks and gill-covers as well as over the body. The snout is more or less pointed, with a single barbel. The mouth is small and toothless; it is inferior in position and is surrounded by thick, fringed lips.

Gono-
rhynchus.

CYPRINI-SILURIFORMES (Carps and Cat-fishes).

The Cyprini-siluriformes, also known as Ostariophysi, are a suborder of fishes which, though many exhibit remarkable differences in general appearance, all agree in the coalescence of the foremost vertebræ, usually four in number, and the detachment of some of their lateral parts to form a link-work known as the Weberian ossicles, which serve to connect the air-bladder with the ear (see specimen 366 in Wall-case 9). The fishes agree with those of the previous suborder, the Salmoni-clupeiformes, in the presence of a mesocoracoid bone in the pectoral girdle, a bone which does not occur in any of the suborders that follow. The fins are without spines, or the dorsal and pectoral fins may

Wall-
case 8.

have a single spine each. The great majority of the fresh-water fishes of the world belong to this suborder, the principal forms included being the Characinids, the Electric Eel, the Carps and Cat-fishes.

Chara-
cinidæ.

The Characinids are fresh-water fishes occurring in Central Africa and South America, with the jaws usually well armed with teeth, which differ much in shape and arrangement in the genera comprised. The body is covered with scales, an adipose dorsal fin is often present, and there are no barbels.

Tiger-fish.

The Tiger-fishes, as the species of *Hydrocyon* (306) are called, are among the most formidable of the Characinidæ. They grow to the size of the Salmon, and on account of the powerful jaws armed with strong teeth, visible when the mouth is closed, and on account of their vicious disposition, they are justly dreaded. The Tiger-fishes are found in the rivers and lakes of tropical Africa, and in the Nile district are known as Kelb-el-Bahr or Dogs of the Water.

Cariba.

The Piranha or Cariba, as the species of *Serrasalmo* (313) and *Myletes* (308) of South America are called, are not less ferocious than the Tiger-fishes of Africa. Their bite has been compared to the cut of a razor. They abound in some rivers and bite pieces of flesh out of the legs of persons entering the water; the smell of blood attracts others in great numbers, and the situation of a person swimming becomes very critical. They do not exceed two feet in length. One of their principal distinguishing features is the serration of the belly.

A skull of *Salminus* (311) is exhibited to show the cheek-plates and the characters of the dentition. *Salminus* is an American genus, the largest species being the "Dorado" of the Spaniards, *Salminus orbignianus*, which grows to a length of three feet and is of predaceous habits, pursuing other fishes moving in shoals. *Macrodon* and *Erythrinus* (305) of tropical America are examples of Characinids not possessing the adipose dorsal fin.

Nile
Moon-
fish.

The Moon-fish of the Nile, *Citharinus geoffroyi*, is represented by a skeleton (314), which shows the feebleness of the dentition of this herbivorous fish, and the deep, compressed form of its body. The fish is often depicted on the monuments of the ancient Egyptians.

Although the fishes of the family Gymnotidæ have long, eel-like bodies (fig. 52), and *Gymnotus* itself is called the "Electric Eel," they are not related to the Eels. The presence of the Weberian ossicles in the Gymnotidæ and their absence in the Eels is alone sufficient to satisfy one that the resemblance is superficial only. The Gymnotidæ are in all probability degraded forms of Characinidæ. They are confined to the fresh waters of Central and South America.

Gymno-
tidæ.

The Electric Eel (315) grows to a length of eight feet. It is found in the marshes and shallow parts of rivers of the northern part of South America, and renders the fording of such rivers dangerous, since the horses frequently fall when they receive an

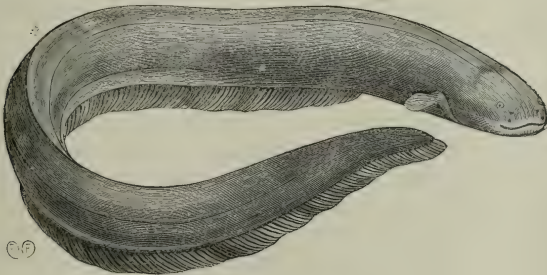
Electric
Eel.

FIG. 52.—Electric Eel, *Gymnotus electricus*.

electric shock from the fish. After delivering two or three shocks the fish is exhausted, and is harmless for a time, and although Humboldt's story of the natives catching Electric Eels by first driving horses into the water for the fishes to discharge their shocks upon has not been confirmed by later travellers, it may nevertheless be based on fact.

Gymnotus is the only member of the family Gymnotidæ which possesses electric organs. These organs are composed of modified muscular tissue; they are richly supplied with nerves connected with the spinal cord, and they consist of compartments with fibrous walls enclosing a stiff jelly, arranged in the form of a band

along each side of the tail, which constitutes nearly the whole of the length of the body, for the anus is set very far forward, under the throat. Similar but smaller electric organs occur in the base of the anal fin.

Cyprinidæ.

The family Cyprinidæ, including the Carps and their allies, is composed of fishes with a small mouth-opening, and with no teeth in the jaws, but by way of compensation the gill-teeth, borne by the lower bones of the last gill-arch, are very strongly developed—see, for instance, those of the Mahseer, 331, in the upper part of the case—and the bones themselves are sharply bent (falciform), one of the distinctive features of the family. These pharyngeal teeth are disposed in one, two or three rows on each side. The body is clothed with scales and there are no bony scutes in the skin such as occur in the next family, the Siluridæ or Cat-fishes; there is no adipose dorsal fin. These fishes feed mostly on vegetable substances or small animals.

The Cyprinids are abundant in the fresh waters of the Old World and North America; there are comparatively few species in Africa, where they coexist with the Characinids, and they are absent from South America, where the Characinids take their place as the predominant fresh-water fishes. They do not occur in Australia.

Suckers.

The Suckers of the lakes and rivers of North America are species of *Catostomus* (e. g. *Catostomus teres*, 316); they have thick, fleshy lips and no barbels; the dorsal fin extends over a considerable portion of the back and the anal fin is short in the base. The pharyngeal teeth are numerous and are arranged in a single row, forming a kind of comb (317).

In the Carps, as the various species of the genus *Cyprinus* are called, the pharyngeal teeth are arranged in three series and bite against a well-developed hard pad supported by a down-growth of bone from the base of the cranium. The Carps are indigenous in the temperate regions of Asia, but many have been introduced into European waters and have become thoroughly naturalised.

Carp.

The Common Carp, *Cyprinus carpio* (318), was introduced into Europe in the thirteenth century, and was first brought into England in the beginning of the seventeenth century. The Carp

subsists on vegetable food and small animals, such as aquatic insects, small pond-snails and worms, and can live for some time out of water. It delights in tranquil waters, particularly those with a muddy bottom and partially shaded by trees; it is a fish of sluggish habits except during the breeding season, when it becomes very excited and frequently leaps out of the water. The Carp is eaten in inland countries, but it is not valued in parts where sea fish are obtainable. Carps have been known to live to a great age (50 to 100 years), and to attain a weight of 20 to 50 lbs., and a length of four feet or more.

In a state of domestication there have arisen two breeds of Carp that tend to lose their scales. In Central Europe there is one form known as the Mirror Carp or "Spiegel-karpfen" (320) which retains large, bright scales along the side of the body and large dull scales on the back, and another form, the Leather Carp or "Leder-karpfen" (319), which has very few scales, if any at all, and the skin is thick and leathery.

Mirror
Carp.

The Crucian Carp, *Cyprinus vulgaris* (322), differs from the Common Carp in having no barbels, and in the different arrangement of the pharyngeal teeth. The iris is silvery, whereas in the Carp it is golden. This fish rarely exceeds six or seven inches in length, but may weigh as much as 2 lbs. The Crucian Carp was probably introduced into England from Hamburg, for in the earliest references to this as an English fish it is called the "Hamburg Carp." The term Crucian is evidently a corruption of "Karausche," the German name of the fish. The Prussian Carp is but a lean and elongated variety of the Crucian Carp.

Crucian
Carp.

The Gold-fish (323) is a golden yellow or red breed of Carp-like fish produced as the result of artificial selection in China and Japan; it has been introduced into Europe and America as an ornamental fish for aquaria and ponds in gardens and parks. The brilliancy generally diminishes when the fish are kept in the open, and they tend to revert to their original greenish colour. Many varieties and monstrosities of the Gold-fish have been produced as the result of domestication, and, in the case of their tails, of mutilation.

Gold-fish.

The Catla, *Catla buehanani* (324), is a large Indian fish; it is Carp-like, but the head is more arched between the eyes, there are

Catla.

no barbels, the rami of the mandible are loosely connected, and the dorsal fin is shorter. The Catla attains a length of six feet and a weight of 100 lbs. It ranges through India to the Kistna, and eastward through Bengal and Burma to Siam.

Mahseer.

The Mahseer or Mahsir or Mosal, *Barbus mosal* (329, and fig. 53), is recognisable by the strong smooth dorsal spine, seven or eight branched rays in the anal fin, the fleshy lips, and the very large scales, of which there are 25 to 27 along the lateral line. It is the principal freshwater game fish of India, where it occurs particularly in mountain streams. The Mahseer attains a weight of 250 lbs., although the usual size of fish captured is 12 to 15 lbs. Specimens under ten pounds are good table-fish, but the flesh of larger fish is coarse and oily. The Mahseer is a carnivorous fish, preying chiefly on fishes.

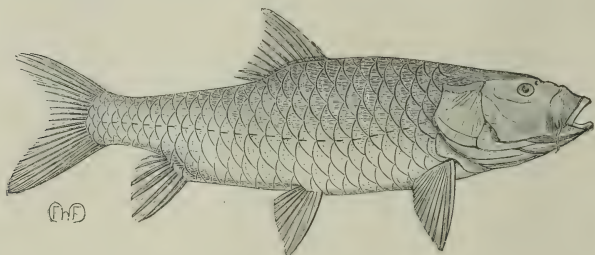


FIG. 53.—Mahseer, *Barbus mosal*.

Barbel.

The only species of *Barbus* found in British waters is the Barbel, *Barbus vulgaris* (327), and this is restricted to the valleys of the Thames and Trent. On the continent the Barbel abounds in almost all the rivers of Central Europe. The Barbel is long for a Cyprinoid fish; the head is elongated, with a projecting fleshy upper lip and small eyes set high up and far back. Four barbels hang down from the upper lip, two from the fore part of the snout and two from the angles of the mouth. It is from these conspicuous "feelers" that the fish takes its popular name. Specimens of 18 lbs. have been taken from the Thames, but at the present day it is rarely that one over 12 lbs. is caught. The Barbel are sociable fishes and collect in shoals where food is

plentiful. They are ground-feeders and are not very fastidious in their diet. The Barbel is rarely eaten except by the poorest people, its liability to convey tape-worms unless the flesh be very thoroughly cooked rendering it undesirable for the table. The roe, also, is sometimes poisonous.

The Gudgeon, *Gobio fluviatilis* (332), is a small fish similar in general proportions to the Barbel, but having only two barbels instead of four, and lacking the spine in front of the dorsal fin which the Barbel possesses. The Gudgeons prefer clear running water, although on the continent they are found in still lakes. They are gregarious, moving about in large shoals; they feed on small animals, such as insect larvæ, crustaceans and worms. In England the Gudgeon grows to six inches.

The species of *Leuciscus*, known in a general way as "White-fish," are abundant in the temperate parts of Europe, Asia and North America. Of the European forms the commonest are the

Roach,
Chub,
Dace,
&c.



FIG. 54.—Lower Pharyngeal Bones of the Chub, showing the teeth.

Roach, *Leuciscus rutilus*, 341, spread all over Europe north of the Alps; the Chub, *Leuciscus cephalus*, 338, with a more southern distribution, extending even into Asia Minor; the Dace, *Leuciscus vulgaris*, 343; the Ide or Nerfling, *Leuciscus idus*, in the northern and central parts of Europe, but absent from Britain; the Rudd or Red-eye, *Leuciscus erythrophthalmus*, 335; and the Minnow, *Leuciscus phoxinus*, 334. The scientific differences between the above species are based on the position of the dorsal fin, the number of scales in the lateral line, the arrangement of the pharyngeal teeth (see fig. 54), and the numbers of fin-rays in the several fins.

The Roach grows to 2 or 2½ lbs. The Rudd is deeper in

the body than the Roach, and the pelvic fins are farther forward relatively to the front point of the base of the dorsal fin. The eye also is redder. The Chub is readily distinguished by its thick, plump body and its heavy head. It rarely exceeds 5 lbs. and a length of 20 inches, although larger specimens are on record. The Dace is generally recognised by anglers by the absence of red colour in the pelvic and anal fins, and by the pure silvery colour of the sides of the body. The maximum weight is about 1 lb. The Minnow seldom exceeds 3 inches, although in favourable localities it may attain twice that length. The long, thick body and the brown and green colouring distinguish it from the young of any of the above species of *Leuciscus*.

Orfe. The Ide or Nerfling, *Leuciscus idus*, is a European species which in Germany is domesticated and assumes more or less the golden hue of the Gold-fish. Such forms are known as Golden Orfe, 344.

Azurine. The fish known as the Azurine, 337, is a bluish variety of the Rudd; it occurs in the middle of continental Europe, and at one time was found in some parts of England, for instance, at Knowsley in Lancashire.

Tench. The Tench, *Tinca vulgaris*, 345, is found all over Europe in stagnant waters with a muddy or clayey bottom. The scales of the fish are small and deeply embedded in the skin, which is thick and slimy. A short barbel occurs at the angle of the mouth on each side; the pharyngeal teeth, 347, are wedge-shaped, slightly hooked at the end, and arranged in a single series. The Tench is an animal of leisurely movement and sluggish disposition, except during the breeding-season, and passes the winter in a state of torpidity. In England the Tench seldom exceeds 4 lbs. in weight. In a state of domestication the Tench may be made to acquire a golden colour similar to that of the Gold-fish and the Golden Orfe. Such a fish is called a Golden Tench, 346.

Bitterling. The Bitterling, *Rhodeus amarus*, 348, is a small European fish, the female of which deposits its eggs in the mantle-cavity of the Pond-Mussel by means of a long external genital tube or ovipositor, which is developed in the breeding-season and dwindles away afterward. Sometimes the tube is as long as the fish itself. The eggs undergo their early development in the gills of the

Mussel, and the fry take their departure in about a month's time. The young fishes cannot be regarded as parasites in the gill of the mollusc, since they subsist solely on the yolk that is present in the egg. All that they enjoy is apparently the safety of the secluded position and a current of fresh water which the Mussel keeps circulating through its gills for its own respiratory processes. The young of the Pond-Mussel, when discharged by their parent as free-swimming little creatures, have a way of hooking themselves on to the skin of freshwater fishes, and living embedded in the skin for some time before they escape and settle down in the mud to complete their growth. The breeding-seasons of the Mussel and the Bitterling coincide, and the Mussel takes its revenge, so to speak, on the Bitterling by discharging its own young upon the mother-fish, so that the skin of the latter becomes a nursing-ground for the young Mussels.

The Bream, *Abramis brama*, 349, may be distinguished from the other fresh-water fish of Britain by the great depth of its laterally compressed body and the considerable length of the base of the anal fin. The dorsal fin has a short base and stands high, and the lower lobe of the tail-fin is longer than the upper. The scales are rather large and number 51 to 57 along the lateral line. The Bream is as much at home in rivers as in lakes, and is found in most parts of temperate Europe north of the Alps. The fishes swim in large shoals and feed partly on water-weeds and partly on aquatic insects and worms. The average weight of a Bream in England is between 2 and 4 lbs., but a specimen has been caught in the Serpentine, in Hyde Park, weighing more than 7 lbs., and larger sizes are on record.

Bream.

The White Bream or Bream-flat, *Abramis blicca*, 351, is a smaller fish than the Common Bream, and in England not so abundant. It is one of the commonest fishes of Central Europe. The colour is whiter and more silvery than that of the Bream, and less brown and brassy, the lobes of the tail-fin are not so unequal, and the pharyngeal teeth are arranged in two rows on each side instead of in a single row. The fish rarely exceeds 1 lb. in weight, or a foot in length.

Bream-flat.

The Carp family is remarkable for the fact that some of the different forms cross-breed in a state of nature, *i. e.* not in

Hybrids.

an aquarium, and produce (apparently) fertile hybrids. The Pomeranian Bream, *Abramis buggenhagii*, 1161, Cabinet-case 31, is in all probability a hybrid between the Common Bream, *Abramis brama*, 349, and the Roach, *Leuciscus rutilus*, 341. The characters of the Pomeranian Bream are intermediate between those of the Common Bream and the Roach, and the fish occurs in localities where both the Common Bream and the Roach exist, in England, Holland, Germany, Austria, &c. *Bliccopsis erythrophthalmoides*, 1168, Cabinet-case 31, a fish found in Holland and Germany, is regarded as a natural hybrid between the Bream-flat, *Abramis blicca*, 351, and the Rudd, *Leuciscus erythrophthalmus*, 335, and several other hybrids are recorded between species of *Leuciscus* and those of *Abramis*, *Alburnus* and *Chondrostoma*. A hybrid is also supposed to exist between the Roach and the Rudd, and such a form has been described under the name *Leuciscus affinis*.

Natural hybrids, *i. e.* the offspring of different species pairing in a state of nature, are extremely rare, but within the class of Fishes there is yet another instance which may be regarded as genuine, and that is the hybrid between the Turbot and Brill (1167, Cabinet-case 31). The Grimsby fishermen occasionally come across a fish which is intermediate in characters between the Turbot and the Brill and which they call a hybrid. Since it has been found possible in the artificial conditions of a marine laboratory to fertilise the eggs of the one species of fish with the sperms of the other and to rear the young up to a certain stage of development, it is very possible that they may be right.

Bleak.

The Bleak, *Alburnus lucidus*, 352, is a brilliant, silvery little fish, deriving its name from an Anglo-Saxon word meaning "shining." In hot summer weather it hovers a few inches below the surface of the water and glitters with silvery lustre in the sunlight as it darts after flies or any small objects floating on the surface. As in the Bream the anal fin has a long base, and the hinder part of the abdomen ends below in a sharp keel. The Bleak seldom grows to more than 4 or 5 inches in length.

Artificial
Pearls.

From the scales of the Bleak is obtained a silvery powder, one of the principal constituents of which is guanin, employed in

the manufacture of artificial pearls. The process by which this glittering material is refined and utilised is said to have originated with the Chinese; the industry has been established in France for more than two hundred years. The most silvery scales are picked out and scraped, and the iridescent pigment allowed to collect at the bottom of the water as a sediment. This is placed in liquid ammonia and sold as "essence d'orient." Small glass bulbs are coated on the inner surface with this substance, and the interior filled with a hard wax. The outer surface of the glass is sometimes dulled with hydrofluoric acid to increase the illusion, and, perfectly spherical pearls being very scarce, the manufacturers of these imitation pearls even go to the length of blowing the bulbs irregular and lop-sided. Most of the "essence d'orient" is made from the scales of the Bleak, but that obtained from Whitebait is of superior quality and greater brilliance.

In the Loaches there are from three to six pairs of barbels around the mouth; the pharyngeal teeth are in one row and in moderate number. The anterior part of the air-bladder is divided into a right and left chamber and enclosed in a bony capsule. The Loaches have a low, elongate body, with or without minute scales. They are distributed over Europe, Asia, Abyssinia, &c. They are fishes of small size, living in small streams and ponds and avoiding large rivers.

Loach.

In consequence of the close connection that exists between the skin and the air-bladder, and between the air-bladder and the ear, the fishes are very sensitive to changes in temperature and pressure, and are known in parts of Germany as "Wetterfisch" or Weather-Fishes. The commonest European Loaches are the Stone Loach, *Nemachilus barbatulus*, 353; the Spined Loach, *Cobitis tania*, 355; and the Pond Loach, *Misgurnus fossilis*, 354, the largest of the three, growing to about 10 or 11 inches.

The Spined Loach, which is scarce in Britain, may be distinguished from the other two by the presence of a small, erectile, bifid spine below the eye. The Pond Loach has 10 or 12 barbels, four of which are on the lower jaw; the Stone Loach has 6 barbels, none of which are on the mandible. The Pond Loach occurs in stagnant waters of eastern and southern Germany and

eastern Europe; it is not found in Britain. The Stone Loach occurs in Britain and on the continent, except Scandinavia; it frequents fast-running streams with stony bottom.

Cat-fishes.

Wall-
cases 9
and 10.

The family of the Siluridæ or Cat-fishes is a large one widely spread over the fresh-waters of the temperate and tropical regions; a few of the Cat-fishes are found in the sea (e. g. *Arius* (376), *Galeichthys* (377) and *Plotosus*), but they keep near the coast. They are all bottom-feeders, of carnivorous tendencies. The body has no scales, but in many genera it is armoured with bony scutes, more or less sculptured. A strong bony spine is frequently present in front of the dorsal and pectoral fins, and large bony plates occur in the skin at their bases. The spines are sometimes barbed or serrated, and constitute formidable weapons. They are not strictly comparable with the spines of Acanthoptergian fishes, such as the Perch (507, Wall-case 12) and Bass (511, Wall-case 13), since they are formed by the fusion of the pieces of a jointed fin-ray, the fusion taking place during the growth of the fish. One to four pairs of barbels usually occur around the mouth; an adipose fin is frequently present.

The division of the family into subfamilies and genera is based upon the extent of the dorsal fin, the presence or absence of an adipose fin, and the fusion of the lower parts of the gill-covers with the "isthmus" under the throat, or their freedom from it. In *Clarias* (359) and *Copidoglanis* (361), for instance, the dorsal and anal fins are long-based and extend to the tail-fin, whereas in the other forms shown the dorsal fin is short-based. The anal fin is long-based in *Silurus* (364), *Wallago* (367), *Silondia* (368), but not in *Amiurus* (373), *Rita* (371), &c. An adipose fin is present in the last two, and in *Doras* (379), *Synodontis* (381), &c., but is wanting in *Silurus* (364), *Silondia* (368), &c. In the Electric Cat-fish, *Malopterurus*, 386, an adipose fin is present, whereas the anterior dorsal fin supported by fin-rays is wanting.

Some Siluroids are provided with an accessory breathing organ. *Clarias* (359, and fig. 55) and *Heterobranchus* have a dendritic organ situated above the gills which enables the fish to live out of water for some time. In the dry season these fishes live in burrows in the mud and crawl out at nights in search of food. In *Sac-*

cobbranchus (363) there is a long air-sac—not the air-bladder, which is also present, enclosed in a bony envelope—but a thin-walled sac extending from the first gill-slit on each side along the body as far back as the tail, and this allows the fish to exist out

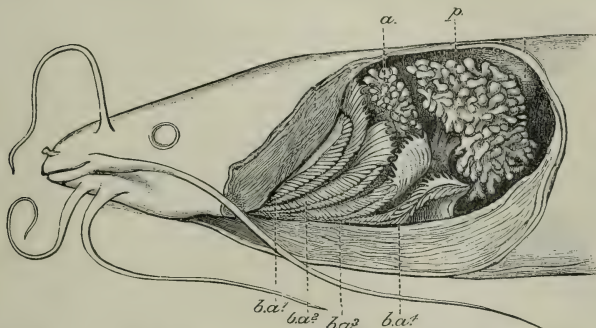


FIG. 55.—Accessory respiratory organ of *Clarias* as seen after the removal of the gill-cover: *a* and *p* the two accessory organs, *ba¹*–*ba⁴* the gills. (After Bridge, Camb. Nat. Hist., vii, 1904.)

of water for several days. The aërated blood from these air-sacs is carried back into the general circulation by means of the efferent vessels of the last gills, which join the aorta; the blood is not taken back straight to the heart. Most Siluroids can live in foul water even though not provided with accessory organs of respiration; they rise to the surface and take in air through their mouth.

The Wels, *Silurus glanis*, 364, is a fish occurring plentifully in the Danube and other fresh waters of continental Europe, but absent from France, Spain and Italy. It is said to grow to a length of ten feet and a weight of three or four hundred pounds. The male watches over the eggs and defends them from marauders, a fact which was noted by Aristotle. In the North American Bull-heads (*Amiurus*, 373) also the male guards the eggs, and defends the young after they are hatched. *Arius* (376) and *Galeichthys* (377), guard the eggs by carrying them in the capacious mouth, the male, more rarely the female, being the

Wels.

custodian. The eggs of *Arius* are large, of about the size of cherries (1146, Cabinet-case 29).

Clarias (359) occurs in the muddy and marshy fresh waters of Africa and South Asia, *Copidoglanis* (361) occurs in Asia and Australia, and *Saccobranchus* (362) in the rivers of the East Indies.

Doras (379) is distinguished by a series of bony scutes along the middle of the side. It travels over land in the dry season in search of a pond of greater capacity; its progress is fairly rapid, and is effected by a springing movement of the tail, the spines of the outspread pectoral fins serving to prevent the body from rolling over sideways. These fishes make nests and both sexes tend the eggs. They occur in those rivers of tropical South America that flow into the Atlantic.

Schal. *Synodontis* of the African rivers has a way of floating belly upwards at the surface of the water, a curious habit which is represented in many of the drawings of the ancient Egyptians. One of the commonest species of the Nile is the Schal, *Synodontis schal* (skeleton, 382), which grows sometimes to two feet in length.

Electric
Cat-fish.

The Electric Cat-fish, *Malopterurus electricus* (383, and fig. 56), a fish not uncommon in the fresh waters of tropical Africa, has no

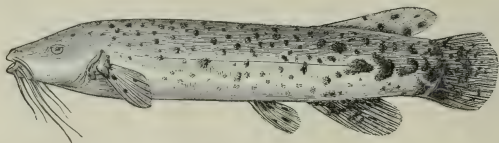


FIG. 56.—Electric Cat-fish, *Malopterurus electricus*.

front dorsal fin; it has a large adipose dorsal set far back, and a short-based anal fin. The skin is soft and velvety, without scales or scutes; the gill-opening is narrow, a mere slit in front of the pectoral fin. There are three pairs of barbels. The eyes are small, and the fish avoids light and is slow in its movements. The electric organ extends over the whole body beneath the skin, but is thickest on the abdomen. It consists of connective tissue compartments filled with a firm jelly; it is an organ of cutaneous

origin and is not constituted of modified muscles as is the case in the Electric Eel (315, Wall-case 8).

Callichthys (384, and fig. 57), a small fish of the rivers of the northern parts of South America, is remarkable for the cuirass which covers in the whole of the soft parts of the body. The armour consists of an upper and a lower row of large, overlapping

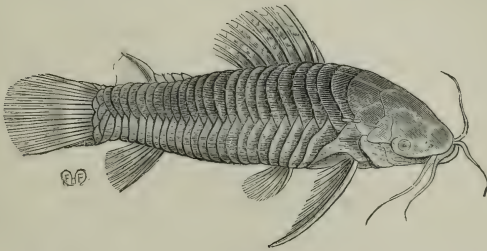


FIG. 57.—An armoured Cat-fish, *Callichthys littoralis*.

shields on each side, each shield being much higher than wide. The adipose fin is supported anteriorly by a short, movable spine.

In the Loricariidæ and Aspredinidæ (Wall-case 10, floor) there is a resemblance to the Siluridæ in the absence of scales, the fusion of the parietal bones with the supraoccipital, the absence of the symplectic bone, and the presence of barbels and an adipose fin, but there is a difference in the ribs being sessile upon the centra of the vertebræ and not supported on transverse processes. In the Loricariidæ the mouth is inferior, with circular lips, and feeble dentition. In the forms like *Plecostomus* (387) and *Loricaria* (386), which have a body cuirass of bony plates, the ribs are slender, but in those which have an unprotected skin the ribs are strong. The Loricariidæ are confined to tropical and sub-tropical parts of Central and South America. Many are of small size; the males of some species have a bearded or bristly snout.

Lori-
cariidæ.

In the Aspredinidæ the mouth is terminal; the head is much flattened; there are no scutes; the tail is slender. *Aspredo* (390), of the Guianas, is the largest of the genera. The female attaches the eggs to the under surface of her body by pressing upon them, when they become embedded in the skin, which is

Aspredo.

soft and spongy during the breeding-season. After the breeding-season the skin again becomes smooth and firm.

ANGUILLIFORMES (Eels).

Wall-case
8, lower
part.

The suborder Anguilliformes or Apodes embraces the "Eels," using the term in the widest sense. In these fishes the body is very long, and without pelvic fins (whence the name "Apodes"). The dorsal and anal fins are in a few cases wanting; in most they are long-based and continuous around the hind end of the body, there being no separate tail-fin. None of the fins have hard or "spinous" fin-rays. The vertebræ are very numerous, as one would expect in such long-bodied fishes; the shoulder-girdle is not attached to the back of the cranium and has no mesocoracoid bone. The premaxillary bones are absent, and the maxillæ are separated by the coalesced ethmoid and vomerine bones. The two parietal bones meet in a median suture; there is no separate symplectic bone.

The Eels are widely spread over the temperate and tropical zones; some occur at great depths of the sea. A few, such as the Common Eel, enter fresh water to feed and grow, but they return to the sea to breed.

An-
guillidæ.

In the family Anguillidæ are included important food-fishes like the Common or Fresh-water Eel, *Anguilla vulgaris* (395), and the Conger, *Conger vulgaris* (396). In *Anguilla* there are rudimentary scales, oblong in form, deeply embedded in the skin and arranged in small groups, the scales of each group being oblique to the length of the body and at right-angles to the scales of the groups above and below. In the genus *Conger* scales are wanting.

Common
Eel.

The Common Eel, *Anguilla vulgaris* (395), has a very wide distribution in the Northern hemisphere, extending through Europe, North Africa and Asia, but not occurring in the rivers discharging into the Arctic Ocean, the Black Sea and the Caspian Sea. This Eel probably also occurs in America and the West Indies, although the Americans name their common Eel *Anguilla chrisypa*. The Eel of the fresh-waters of Australia and New Zealand is of another species.

Owing to the fact that the generative organs of the Common Eel do not ripen in fresh water, numerous erroneous impressions have arisen concerning the mode of propagation of the fish, which have only recently been dispelled. It is now definitely established that when five or six years old the Eels migrate to the sea to breed, and they do not return to fresh water. The males have been observed to precede the females, from which they may be distinguished by the sharper form of the snout; in fact, what in England are called the Sharp-nosed Eel and the Broad-nosed Eel are but the immature males and females of the same species of fish.

On their way to the breeding place, a zone of the Atlantic off the West of Ireland and France where the water is about five or six hundred fathoms deep, the skin of the fish becomes silvery and bright, the eyes large and dark, and the reproductive organs become fully developed. The Eels spawn at the great depth above mentioned, in the middle of winter, and the innumerable young hatched from the eggs grow to a length of nearly three inches, as the flat, transparent "*Leptocephali*."

These larvæ (fig. 58 A, p. 118) have perfectly clear, ribbon-like bodies, transparent as glass, and free from colour excepting the eyes, which are black, and are alone visible when the little fish is observed in a jar of clear sea-water. They are called *Leptocephali* on account of the small size of their head. The generic name "*Leptocephalus*" was applied to the Eel-larvæ before their history was known, and it is now merely used to distinguish a stage in the life history of various species of *Anguilla*, *Conger*, *Congromuræna*, and other "Eels." Thus, *Leptocephalus brevirostris* is the larval form of the Common Eel, *Anguilla vulgaris*; *Leptocephalus morrisii* that of the Conger Eel, *Conger vulgaris*, and so on.

The *Leptocephalus* develops from the egg and grows to about three inches in length, and then ceases to feed, and takes no food again until the metamorphosis is complete and the little fish has become an "Elver" (see fig. 58 D).

As the metamorphosis of the *Leptocephalus* into the Elver proceeds, the temporary teeth in the upper jaw are shed, and the pointed snout becomes rounded. The height of the body becomes reduced, first in the anterior and posterior parts, later in the middle

parts, so that the body becomes nearly cylindrical. In the later stages the length also diminishes. Pigment is developed in the skin, and the eyes become slightly reduced during the metamorphosis.

During the later stages of the metamorphosis the little fish become very active, and they swim in enormous numbers in an

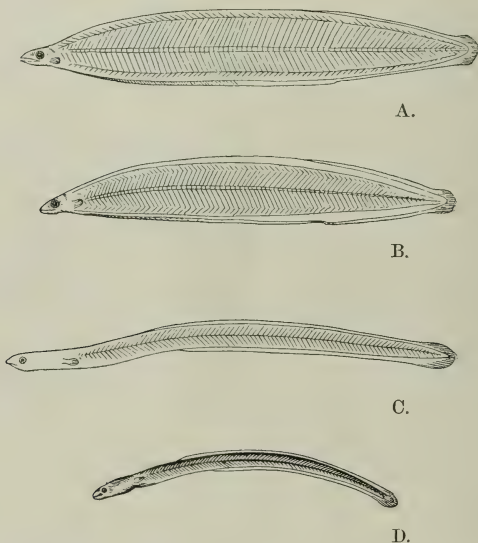


FIG. 58.—Metamorphosis of the Common Eel, *Anguilla vulgaris*.

- A. The larva, known as *Leptocephalus brevirostris*.
- B. Later stage, the metamorphosis commencing.
- C. Transition stage; Glass Elver.
- D. Elver, from fresh water, the metamorphosis complete.

All of the figures are of the natural size.

easterly direction, arriving at the mouths of the western rivers of Ireland, England and France in the spring. While in the sea they are still colourless, and are known as "Glass Elvers," but as they get into fresh water they develop pigment in the skin, and then are "Elvers" (see fig. 58 C and D).

The Elvers ascend our rivers in millions ; some climb the banks of the rivers and streams and pass over wet fields, eventually reaching suitable ponds ; others stay in holes in the muddy banks of the streams. The Elvers are greatly reduced in numbers as the migration proceeds, many being eaten by fish such as the Pike, and by birds, while for human consumption vast quantities are caught and sold during the "Eel-fare," as the migration of the Elvers is termed.

There are no reliable statistics of the British Eel-fisheries ; in Denmark they are important and produce an annual yield of over £100,000 in value. Eels are caught usually in traps of basket-work or netting, especially during their migrations to the Atlantic in autumn for the purpose of spawning.

Eels are voracious feeders and diligently poke their noses under small and large stones, and laboriously move the large ones, sometimes assisting one another in their search for crustaceans, fishes, spawn, &c., upon which they feed. They are extremely rapid in their movements, and when well grown have few enemies but man ; the Pike, however, commits great depredations among the young ones.

Eels grow naturally to about three feet. If prevented from descending to the sea they grow to four feet or more, and one specimen has been known to live to the age of forty years in fresh water. The Eel is an excellent food-fish, the flesh being of agreeable flavour, and tender if properly cooked, although becoming tough and leathery in inexperienced hands.

The Conger (396) is a purely marine fish, and prefers deep waters with a rocky bottom. It is almost cosmopolitan and is widely distributed along the coasts of the North Atlantic, Mediterranean, Japan, Tasmania, &c. It is caught on long-lines, and in the British Isles the fishery yields about 70,000 cwts. annually, valued at nearly £50,000. The Conger is a coarser fish than the *Anguilla* and grows to a larger size, the female sometimes attaining a length of eight feet ; the male rarely exceeds two feet. A Conger may be readily distinguished from a Common Eel by the dorsal fin commencing nearer the head than in the latter. Conger.

The *Nemichthyidæ* differ from the *Anguillidæ* in the vent being set forward, close to the gill-openings ; the gill-openings are wide, *Nemichthyidæ.*

and nearly confluent. The eyes are large. The fin-membrane between the rays of the dorsal and anal fins is thin, and in some genera, like *Nemichthys* (398), the jaws are remarkably long and feeble, forming a slender beak or bill. The Nemichthyidæ are deep-sea fishes found in the great oceans of the world, and do not attain any great size.

Saccopharyngidæ.

The Saccopharyngidæ, known in America as "Gulpers," are very grotesque fishes of the deep seas, more or less allied to the Eels (see fig. 6, p. 18). The mouth is very large, and the stomach is extremely distensible and capable of accommodating prey of larger size than the fish itself. The eyes are small and set far forward, the tail is long and slender, ending in a filament. The skeleton is imperfectly calcified. Examples of *Saccopharynx* (986) and *Gastrostomus* (985) are shown in the case of "Deep-sea Fishes," Cabinet-case 44.

Murænidæ.

In the Murænidæ or Morays the branchial openings into the pharynx are narrow slits, whereas they are wide slits in the

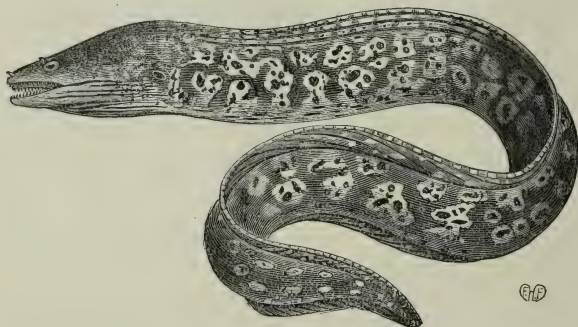


FIG. 59.—Moray, *Muræna helena*.

Anguillidæ; the external gill-opening on each side is small and round. The skin is without scales. The pectoral fins are usually wanting and in some cases the pectoral arch also.

The Murænas are voracious fishes of tropical and subtropical seas and do not hesitate to attack man; they are especially abundant in the vicinity of coral reefs. Many are of large size,

reaching a length of eight or ten feet, and most are of remarkably rich and varied coloration.

Muræna helena, the "Muræna" of the Romans (fig. 59), is largely used as food around the Mediterranean. The species can be domesticated and will live in fresh water. The fishes were extensively kept by the Romans and fattened in special tanks and ponds, and according to certain traditions were fed with the bodies of slaves. The fish is not confined to the Mediterranean, but occurs also in the north-western part of the Indian Ocean, the eastern part of the Atlantic, and is sometimes caught off the coast of England.

ESOCIFORMES (Pikes).

In the suborder Esociformes or Haplomi, including the Pikes and their allies, the anterior vertebræ are without Weberian ossicles, and the shoulder-girdle is connected with the back of the skull. The two parietal bones are usually separated by the supraoccipital. The fins are usually without spines, but the first ray of the dorsal fin is sometimes stiffened and spine-like. There are no barbels. The pelvic fins are abdominal in position. These fishes occur chiefly in fresh water, but some in the deep sea.

Wall-
case 10.

The Galaxiidae are a small family of scaleless fishes in which the parietal bones meet in the middle line of the skull, the post-temporal bone is not forked, and the ribs are attached to strong transverse processes. The chief genus is *Galaxias* (406), occurring in the fresh waters, and in some cases also the seas, of the southern parts of the world, South Australia, New Zealand, the south of South America and the Cape of Good Hope. The settlers in New Zealand called these fishes "Trout" and the young "Whitebait," and the names still survive to a certain extent. The native name of the fish is "Kokopu."

Galaxi-
idæ.

The Esocidae constitute a small family of carnivorous fresh-water fishes including the Pikes and the Umbras or Mud-Minnnows, and ranging through the temperate parts of the northern hemisphere. The upper border of the mouth is supported by the maxillary as well as by the premaxillary bones, but the former are toothless. There are no transverse processes to the trunk vertebræ; the

Esocidæ.

post-temporal bone is forked. The dorsal and anal fins are set far back ; the pectoral fins are set low down the sides of the body ; the pelvic fins have 6-11 rays. The body is clothed with cycloid scales.

Pike.

The Pike, *Esox lucius*, 407, so well known to sportsmen of the rod, hardly requires description. It is limited to fresh water and ranges through Europe, Asia and America. The Pike is an extremely voracious fish, and so great is the havoc wrought by it among more valuable fish, such as the Trout, that in certain districts special measures have to be taken to keep down their numbers. The head is long, broad and flattened, the body is long and somewhat laterally compressed, and the sides themselves are much flattened. The dentition is powerful, and the teeth being sharp, closely set, and with the points directed back towards the throat, there is little chance for the prey to escape when once in contact with the teeth. How efficacious is the dentition is known to all fishermen who in attempting to remove the hook from a large dead fish have had the uncomfortable experience of getting part or the whole of the hand within the mouth. Every movement of the hand causes it to get carried farther and farther into the throat.

The colour of the Pike varies considerably with the seasons. The back is always dark olive, the sides are grey and green with a slight silvery lustre, except at the breeding season, when the colours of both sexes become darker and more vivid. The Pike is a solitary fish, except during the pairing season, and punishes the intrusion of smaller individuals of its own species within its haunts by devouring them. Its food consists of all kinds of fish, frogs, ducklings, the young of water-fowl, &c. The Pike is a strategist in pursuing its prey. It remains perfectly still and rigid, or advances quietly and stealthily, and then by a powerful movement darts forward, and the fish or bird that it was stalking is within its jaws.

The Pike is not commonly eaten, although by some the flesh is considered as not unpleasant. A definite standard of size for a full-grown Pike can hardly be assigned, since the fish continues to enlarge so long as it can get food and avoid its enemies ; neither is it known with certainty to what age Pike will live. The specimen exhibited (407) would rank as a good large fish ; when

caught it weighed 30 lbs. and measured 48 inches in length and 23 inches in girth. Pike under 4 lbs. are usually called "Jack."

The Umbras or Mud-minnows include one species (*Umbra cramerii*) which occurs in Hungary and the countries around, and two others (*Umbra limi*, 409, and *Umbra pygæma*) which are inhabitants of the eastern slope of the American continent and the Mississippi valley. The jaws are not produced as they are in the Pikes, and the teeth are all small. The dorsal fin is set more forward than in the Pikes and the scales are relatively larger. The Umbras frequent still waters and are most at home in muddy and reedy ponds; when startled they burrow tail foremost into the mud. They are small, sluggish and carnivorous.

Umbra.

The family Scopelidæ is a fairly large one, comprising pelagic and deep-sea fishes and some extinct forms from the Cretaceous and Tertiary deposits. The premaxillary bones are long, and exclude the maxillæ from sharing in the support of the upper border of the mouth; the parietal bones are separated; there are no transverse processes to the vertebræ; the post-temporal is forked. An adipose dorsal fin is frequently present, and in the deep-sea forms luminous areas (photophores) occur in the skin of the body and head.

Scopelidæ.

Scopelus (413) is a genus with many species, mostly of small size, with large eyes and with photophores. While some are confined to the depths of the sea others are pelagic, and others again remain in deep water during the day and come to the surface at night. Many of the species occur in the Mediterranean, others in the Atlantic and Pacific Oceans. In the Case of Deep-sea Fishes (Cabinet-case 44) are shown two curious forms belonging to this family. *Bathypterois* (983) is a small-eyed fish, first obtained by the "Challenger," remarkable for the great elongation of the uppermost rays of the pectoral fins, which are forwardly directed and act as "feelers." The foremost rays of the pelvic fins are also elongated, though not to the same extent as those of the pectoral, and by these doubtless the fish feels its way along the bottom of the sea. *Ipnops* (976) is a still more remarkable fish, dredged by the "Challenger" from 1600-2000 fathoms, with no eyes, but

with two luminous patches nearly touching one another on the top of the broad, flat head. The photophores are supposed to attract small fishes as a candle or gas flame attracts moths, and the *Ipnops* having lured such prey into the neighbourhood of its large mouth does not need eyes to see what that prey is before gulping it down.

Bum-
malow.

The Bummalow or Bummaloe, *Harpodon nehereus*, 412, is a uniformly phosphorescent fish, frequently found in great numbers at the surface of the Indian Ocean and even in the estuaries of the coast of Bengal and Burmah. After salting and drying, these fishes are exported in large quantities from Bombay and the Malabar coast and sold under the name of "Bombay Duck," a delicacy familiar to all who have travelled in India.

Aulopus purpurissatus, 414, the "Sergeant Baker" of the Australian fishermen, occurs in moderate depths of the sea off the coast of Australia. It has a small adipose fin, rough, firm scales, and no luminous spots.

Alepidos-
saurus.

The Alepidosauridæ are deep-sea fishes differing from the Scopelidæ in the great size of the dorsal fin, which is supported by long, slender, unjointed fin-rays. An adipose fin is present. The body is without scales; the teeth are formidable; the bones are feebly ossified. These fishes are found in the Atlantic and Pacific Oceans, and include the largest of the deep-sea fishes, some attaining a length of four feet. The skull of *Alepidosaurus ferox* exhibited (415) shows the great predatory teeth and the frailness of the bones; a complete skeleton (1097) in a special glass case is shown elsewhere in the Gallery.

Killie-
fishes.

The Cyprinodonts (e. g. 416) are small fishes occurring in fresh or brackish waters of America (where they are known as Killie-fishes), and in Africa, Southern Europe, and Southern Asia. The head is rather flattened, the mouth is extremely protractile and with the upper border supported by the premaxillaries only. The scales are large and extend more or less over the head. A few Cyprinodonts are herbivorous and have a long intestine, but most are carnivorous and with a short intestine. The females are usually larger than the males and not so brightly coloured, and in many species they are viviparous.

One of the most curious of these fishes is the *Anableps*, or Four-eyed Fish, *Anableps tetrophthalmus*, 417, of the fresh waters of tropical America. This fish has not really four eyes, but its eyes, which bulge considerably, are divided into an upper and a lower portion in such a manner that the fish as it swims at the surface of the water can see both in and out of that medium, the upper part of the eye being adapted for use in air and the lower part for use in water. There is nothing exceptional in the general appearance of the large crystalline lens and the retina, but the iris is curiously altered so as to present two pupils, one above the other. This is effected by a pair of overlapping horizontal flaps of the iris passing across the middle of the originally simple pupil. Four-eyed Fish.

The Amblyopsidæ are small fishes related to the Cyprinodontidæ. They are confined to North America; some live in streams and ditches and have eyes, others occur in subterranean waters of the great limestone caves. These last are blind, the eyes being vestigial and hidden under the skin. The body is colourless and transparent. One of the best known is *Amblyopsis spelæa* (418), the Cave-fish or Blind-fish of the Mammoth Cave of Kentucky. By way of compensation for the loss of vision the sense of hearing is very acute, as also is the tactile sense, there being developed on the head numerous transverse ridges with papillæ, which judging from their abundant nerve supply are delicate organs of touch. The largest specimen known is five inches long. The fish is viviparous, and the young are about a quarter of an inch long when born. Cave-fish.

Physoclisti.

In the grade Physoclisti the air-bladder, although developing as a hollow outgrowth of the alimentary canal, becomes shut off from it by the disappearance of the neck or tube, the "ductus pneumaticus." Some of the Berycoid fishes (Wall-case 12), the most primitive of the Acanthopterygian fishes, are exceptional in this respect. The great majority of the Teleostean fishes belong to the grade Physoclisti; the exhibited series extends from the middle of Wall-case 10 along the North and East Walls to the other end of the Gallery (Wall-case 20). Wall-case 10.

HALOSAURIFORMES.

The Halosauriformes or Heteromi constitute a small suborder of fishes, mostly confined to the deep seas. The pelvic fins, if present, have many fin-rays (about 10) and are set far back (abdominal position); the pectoral fins are set high up the sides of the body; the right and left parietal bones meet. The mesocoracoid bone in the shoulder-girdle is reduced or absent; the post-temporal bone is small and simple. The suborder includes the families Halosauridæ, Notacanthidæ, Dercetidæ (extinct; Cretaceous), and Fierasferidæ.

The Halosauridæ and Notacanthidæ are long-bodied, deep-sea fishes, with tail tapering to a point and without a separate caudal fin. The body is clothed with cycloid scales, which extend also partly over the head. In the latter family (e. g. *Notacanthus*, 420) the dorsal fin is represented by a series of short, isolated spines; the anal fin is long, the front part supported by spines, the hinder part by soft rays. In the Halosauridæ (e. g. 419) there are no spines; the dorsal fin has a short base, the anal a long base.

Fierasfer.

Fierasfer (421) is a strange little fish which lives in the bodies of holothurians, starfishes and bivalve molluscs, particularly the Pearl Oyster. It is not a parasite, so far as our present information goes, but catches its own food from the sea water, and enters and leaves the body of its host repeatedly without apparently causing any inconvenience. *Fierasfer* is found near the coast in all warm and tropical seas. It has a long tail, with extended dorsal and anal fins reaching to the extremity, which has no separate caudal fin. The anus is far forward, in the throat region; there are no scales and no pelvic fins.

GASTROSTEIFORMES (Sticklebacks and Sea-horses).

The suborder Gastroteiformes or Catosteomi includes curious fishes, the affinities of which have been the object of much discussion. The least aberrant forms are the Sticklebacks, with

which the Pipe-fishes and Sea-horses are related, in spite of their strangely modified gills (see fig. 61, p. 131). The Opah or King-fish, though so different in appearance from the Sticklebacks, would seem to be more closely allied to these than to any other fishes.

The family Lamprididæ, constituting the division Selenichthyes of some authors, contains only the fish just mentioned, the Opah, *Lampris luna*, Floor-case 27. This is a large fish, attaining sometimes the length of four feet. The body is short and deep, and laterally compressed; it is covered with minute scales; the snout is short and the mouth toothless. The branchial apparatus is fully developed, and the gills are of the ordinary pectinate type. The fins are without spines. The pelvic fins have numerous rays (15-17), and the pelvic bones are connected with the coracoid bones, which are large and do not meet ventrally. The coloration of the Opah is vivid, and the flesh is considered choice. The fish is pelagic in habit and is widely distributed, specimens having been taken in various parts of the Pacific and North Atlantic Oceans, the Mediterranean, and off the coast of England.

Opah.

The Sticklebacks (family Gasterosteidæ) are small fishes, with the dorsal fins armed with two or more spines and with the sides of the body more or less protected by bony shields instead of scales. The pelvic fins are abdominal in position; each has one spine and one or two soft rays; the pectoral fin has no spine, the anal fin has a single spine. The mouth is toothed; the ribs are slender; the anterior vertebræ are not enlarged or only slightly elongated.

Stickle-
back.

The Sticklebacks are widely distributed over the northern seas and fresh waters. Several are British. This family is by some authorities grouped with the Centriscidæ, Amphisilidæ, Aulostomatidæ and Fistulariidæ to constitute the division Hemibranchii, characterised by the possession of pectinate gills, more or less reduced in number, with a complete opercular apparatus; with a small and terminal mouth and the post-temporal bone simple and immovable.

The common Stickleback of England (424) is *Gasterosteus aculeatus*, called also the Three-spined Stickleback from the fact

that at the front of the dorsal fin are three short spines. It is very abundant in all fresh waters, and can be transferred to brackish and sea water without injurious effect. The fish occurs in three varieties; var. *gymnurus*, the smooth-tailed variety, with from four to six bony plates behind the gill-cover; var. *semiarmatus*, the half-armed variety, with from ten to fifteen bony plates behind the gill-cover and a few blunt spines on the side of the base of the tail; and var. *trachurus*, the rough-tailed variety, with an uninterrupted series of from thirty to forty bony plates along the side of the body. From recent observations it appears that the variety *trachurus* is a winter form, the variety *gymnurus* the same fish in summer dress, when it has discarded its armour, and the variety *semiarmatus* a fish caught in the spring. In the case of the American *Gastrosteus cataphractus* the individuals caught in the sea have a complete armour of bony plates, about thirty on each side; those found in brackish water are half-armoured, with from six to twenty plates, while those found in fresh water have only two or three plates or even none at all.

The common Stickleback is an active, persistent and greedy little fish. It is very pugnacious and protracted fights are not uncommon; after the fight the colour of the defeated combatant at once becomes dull, while that of the victor remains resplendent. It is no unusual thing also to see a group of Sticklebacks worrying a fish much larger than themselves by biting little pieces out of the margin of the fins. Sticklebacks do much mischief by devouring the spawn and fry of other fishes.

In the breeding-season the throat and breast become brilliantly red, particularly so in the males. The male builds a nest by collecting bits of water-weed and leaf-skeletons and cementing them together with a glairy fluid which is secreted in glands opening at the urino-genital aperture, and which hardens into tough threads in contact with water (compare the byssal threads of the bivalve molluscs *Pinna* and *Mytilus*, the common Mussel). The nest is constructed prior to mating. A female is then induced to enter the nest and lay her eggs, and when she departs through the other opening, for there are two, one at each end, the male enters and fertilises the eggs. The process is then

repeated with other females in succession, and finally the male takes up his position outside the nest and jealously guards it it against all comers until the young Sticklebacks are hatched. Oddly enough, the most persistent assailants are the mothers themselves, who seek to devour the eggs.

The Ten-spined Stickleback, *Gastrosteus pungitius*, 425, is not so common as the Three-spined Stickleback; it has nine short spines on the back and a longer tenth. The Fifteen-spined Stickleback, *Spinachia vulgaris*, 426, is a marine form, common in rock pools around the British and other coasts of Europe.

The Flute-mouth or Tobacco-pipe-fish, *Fistularia tabaccaria*, 428, has a long, slender body, with the snout produced into a long tube, which has the mouth, small and toothless, situated at the end. The first four vertebræ are much elongated and are fused together; the supratemporal bones are much produced posteriorly. There are no spines in the fins, and no scales, but bony plates, in the skin. There is a distinct caudal fin, which is forked and has the median fin-rays produced into a filament. The fish swims near the surface in shallow seas of the tropical and sub-tropical regions of the globe.

Flute-mouth.

The Aulostomatidæ (427) bear a general resemblance to the Fistulariidæ, but differ in the following respects:—there are spines in front of the dorsal fin, the caudal fin is rhombic, and without the elongated central fin-rays, there are small, ctenoid scales in the skin and small teeth in the jaws.

In the Snipe-fishes (family Centriscidæ, e.g. 430) the body is laterally compressed and deep vertically; the snout is in the form of a tube, with the small toothless mouth at its extremity; some of the anterior vertebræ are elongated; the front part of the dorsal fin has a few spines, one much larger than the others; the anal fin has no spines. Scales are present, also bony scutes dorsally and ventrally, forming an incomplete bony armour which is distinct from the vertebræ. The Common Snipe-fish is widely distributed in warm seas, and is sometimes found off the south coast of England.

Snipe-fish.

The Amphisile (432), sometimes called the Needle-fish or Shrimp-fish, is a curious, semi-transparent little fish, which carries the body with the long axis upright, and cleaves the

Amphisile.

water with its sharp ventral edge. The body is protected by a dermal cuirass which is continuous with the internal skeleton; there are about six large, elongated trunk vertebrae and fourteen very small caudal. The body ends in the two dorsal fins, the first of which bears a strong spine; the tail fin is reduced and is ventral, not terminal in position.

Pipe-
fishes
and Sea-
horses.

The families Solenostomatidae and Syngnathidae agree in having gills which are not comb-like, but reduced to small rounded knobs or lobes borne by the gill-arches (fig. 61); they were formerly grouped in a special division known as the Lophobranchii. Not only are the gills reduced but the gill-cover also; there is no preopercular bone and only a few branchiostegal rays. The skin is strengthened by large, star-shaped, bony plates or by bony rings encircling the body; there are no scales. The muscular system is feebly developed. The snout is prolonged into a tube, and the mouth is small, terminal and toothless.

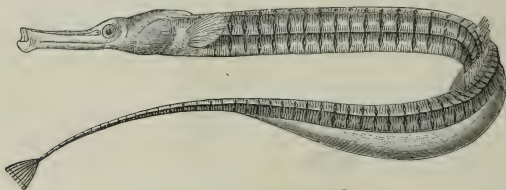


FIG. 60.—Pipe-fish, *Syngnathus acus*.

In the Syngnathidae the gill-opening is small and set high up; the anterior dorsal fin and the pelvic fins are wanting. The eggs are carried by the male in a brood-pouch situated either on the abdomen or on the tail, and usually formed by two folds of skin, right and left. In *Nerophis* (434) and *Gastrotokeus* (437), however, there is no pouch; the eggs are embedded in the soft skin of the abdomen of the male. The Syngnathidae are small and marine, living near the coast in temperate and tropical regions; they are poor swimmers and are carried about passively by currents.

The commonest forms are the Pipe-fishes (e. g. the Greater Pipe-fish, *Syngnathus acus*, 436, and fig. 60, the Ocean Pipe-fish, *Nerophis aquoreus*, 434), which have a tail that is not prehensile.

Solenognathus (438), of the seas of China and Australia, has a short prehensile tail by which it holds on to pieces of sea-weed among which it lives. The Sea-horse, *Hippocampus abdominalis* (440, and fig. 61) has a well-developed prehensile tail, and carries the body in a vertical position. The head is bent at right angles to the body and bears some resemblance to the head of a horse; it is very like the "knight" of the chess-board. In the Dragon-fish, *Phyllopteryx*, 439, the tubercles or spines are produced into large, soft, leafy streamers, composed of skin, and bearing a close resemblance to bits of sea-weed.

The fishes of the family Solenostomatidæ (433) differ from those of the Syngnathidæ in having large pelvic fins and an

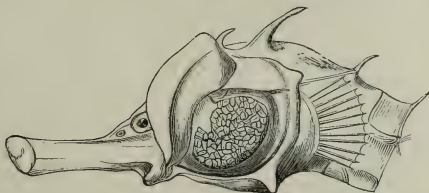


FIG. 61.—Lobular gill of Sea-horse, *Hippocampus abdominalis*, brought into view by turning the gill-cover forward.

(From Günther, "Study of Fishes.")

anterior, spinous dorsal fin, and in the gill-opening being wide. The brood-pouch is constituted by the broad pelvic fins, and occurs in the female.

The Pegasus, *Pegasus volitans*, 443, is an odd little fish found on the sandy shoals of the coasts of Japan, China, India, and Australia. The mouth is on the under side of the head and has no teeth; the gills are pectinate, and not lobular as in the Sea-horses. The body is entirely covered with bony plates, arranged in the form of rings. The pectoral fins are broad and horizontal, like large wings; in the species in question the five front rays have the form of strong spines. These fishes constitute the division Hypostomides. The dried bodies of the Pegasus are frequently used by the Chinese in conjunction with shells

Pegasus.

and bits of red coral in the ornamentation of fancy boxes, many of which are brought to England by sailors and travellers as curios.

MUGILIFORMES (Grey Mulletts).

Wall-
case 11.

The suborder Mugiliformes or Percesoces includes the Sand-eels, Grey Mulletts and Barracudas, and occupies an intermediate position between the Pikes on the one hand and the Perches on the other. The pelvic fins, if present, are abdominal in position, and consist usually of one spine and five soft rays. The pelvic bones are not firmly connected with the shoulder girdle. The shoulder girdle is suspended from the cranium, and has no mesocoracoid bone. The supraoccipital bone extends forwards between the reduced parietal bones.

Skipper.

The first family, the Scombresocidæ, takes its name from *Scombrox*, the Skipper, 451, also known as the Saury, a fish sometimes caught off Britain, and reminiscent of the Mackerels in the possession of a few finlets behind the dorsal and anal fins. The Skippers swim at the surface in large shoals and are pursued by the Tunny and Bonito as well as by Porpoises. Although their fins are small, they are very rapid in their movements, and the fishes spring out of the water and glide along the surface appearing scarcely to touch the water.

Gar-fish.

The Gar-fish, *Belone vulgaris*, 449, of the coasts of Britain, France and the Mediterranean, is less pelagic than the Skipper, and has not the finlets; it is very voracious, and the larger species, not found in British waters, are dangerous to man, not so much from the injury inflicted by the teeth as from the ugly wound that they can make by driving the closed beak into the flesh, as they sometimes do when leaping out of the fisherman's net at the side of the boat. Although the Gar-fish is good eating, it is disliked by many people on account of the green colour of its bones. There is a well-founded prejudice against green pigments other than the green colouring matter (chlorophyll) of leaves and fruits, but it so happens that the green substance in the bones of the Gar-fish is not poisonous. A similar green coloration of the bones is found in the Protopterus or African Lung-fish (Wall-case 6).

The Half-beak, *Hemirhamphus*, 450, of most tropical seas, instead of having the upper and lower jaws both prolonged to form a beak, has only the lower jaw long. It feeds mostly on green seaweeds.

Half-beak.

The Flying-fishes, *Exocætus* (452, and fig. 62) do not have the jaws prolonged ; the teeth are feeble and uniform, the pectoral fins,

Flying-fish.

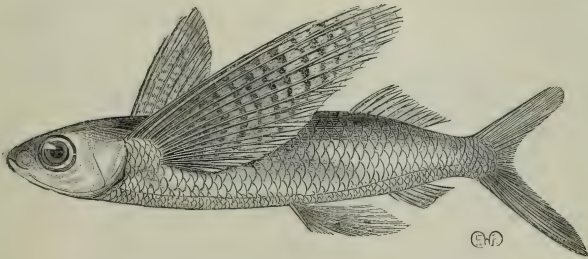


FIG. 62.—A Flying-fish, *Exocætus pilopterus*.

and in some species the pelvic fins also, and the lower lobe of the tail are greatly enlarged. They live in shoals in tropical and sub-tropical seas and are pursued by large fishes such as the Tunny and Albacore. *Exocætus volitans* is a small species, with short pelvic fins, sometimes taken off the British coast ; the largest Flying-fish is the Californian species, which attains a length of eighteen inches.

Although called Flying-fish, the species of *Exocætus* do not really fly. They leave the water with great velocity by a powerful movement of the tail, and then scud through the air until they reach the water again, when another rapid movement of the tail may start them afresh through the air without the whole of the body entering the water. The pectoral fins are not moved as organs of true flight. They may vibrate and quiver somewhat, but the whole motive power is supplied by the strong tail. The movements of the pectoral fins are in no way comparable with these of the wings of a bird ; the fins act as a parachute only.

The Sand-eels or Launces (family Ammodytidae) are small, silvery fishes swimming in shoals near the shore, and remarkable for the manner in which by their sharp pointed snout they bury

Sand-eel.

themselves with great rapidity in the sand, darting in and out like arrows. Sometimes the falling tide leaves a sandy stretch of beach looking like a moving foam of silver through the Launces dodging and wriggling in and out of the wet sand. Both dorsal and anal fins are extended (fig. 63) and without spines. There are no pelvic fins. Two species occur on the British coast, the Greater Launce or Greater Sand-eel, *Ammodytes lanceolatus*, 455, and fig. 63, growing to seventeen inches, and the Lesser Launce or Lesser

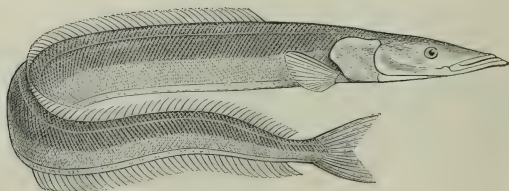


FIG. 63.—Sand-eel, *Ammodytes lanceolatus*.

Sand-eel, *Ammodytes tobianus*, 454, which grows to seven inches, has flatter sides than the Greater Launce, and lives higher up the sandy shoal. They are not much eaten but make excellent bait.

Sand-smelt.

The Atherines or Sand-smelts are small fishes rarely exceeding nine inches in length, of a translucent pale green colour, and with a silvery band along the side. They are littoral fishes, living in shoals in the seas of the temperate and tropical regions of the globe, but some species enter or live entirely in fresh water. *Atherina presbyter*, the Common Sand-smelt, 456, is not uncommon on the British coasts. It is sometimes mistaken for the Smelt, which is a Salmonoid fish (294, Wall-case 7), but the uninitiated can at once tell the Atherine from the true Smelt by the presence of spines in the front dorsal fin. The Sand-smelts are highly esteemed as food; the celebrated 'Pesce Rey' of Chili is a species of *Atherina*.

Grey Mullet.

The Grey Mullet (family Mugilidæ) are robust-looking fishes with broad, blunt head and small, nearly toothless mouth. The scales are cycloid, of moderate size and arranged in regular rows; the first dorsal fin is small and has few spines (usually four) and the pectoral fins are inserted high up. The second portion of the stomach is thick and muscular like the gizzard of a bird, and the

intestine is long and much convoluted. The fishes live on the small organisms contained in the mud and sand; they feed in large parties or schools on the bottom in quiet water with the head downward; the food is sifted in the mouth and the mud and sand rejected. The exhibited specimen of Grey Mullet, *Mugil capito*, 457, is the commonest of the three species found off the British coasts. All Grey Mulletts are valued as food, those taken from fresh water particularly so.

In Honolulu they have a very ingenious plan of rearing the Grey Mullet in Mullet-ponds. Across an arm of the sea is built a stone wall with very numerous small openings between the stones. Through these openings the young Mulletts enter, and they rapidly fatten on the abundant algal and other vegetation of the creek, and become too big to get back through the holes to the open sea. The plan is not without its drawbacks, however, for young Barracudas (*Sphyræna*, e. g. 460) enter the creek through the stone wall in pursuit of the young Mullet and, when inside, feed on the Mullet, and grow too large to get out again.

The Polynemidæ or Thread-fins (459) are allied to the Grey Mulletts. Like them they are of a bluish silvery colour; their eyes are covered with a filmy skin; the scales, however, are more or less ctenoid, and the lowest fin-rays of the pectoral fin are separated by an interval from the rest of the fin and consist of long free filaments, which are organs of touch, and can be moved independently of the functioning fins themselves. In some the filaments are twice as long as the body of the fish. The possession of these tactile filaments is connected with the partiality of the fishes for turbid water. Some of the fishes of this family grow to a length of four feet. From the air-bladder of some of the Indian species a good quality of isinglass is obtained (1186, Cabinet-case 28).

Thread-
fin.

The Chiasmodontidæ, which are represented in the exhibited series by *Chiasmodon nigrum* (978, Cabinet-case 44, and fig. 7, p. 18), are fishes of the depths of the mid-Atlantic, with soft flesh and feeble spines, reduced scales and reduced gill-covers. The dentition is powerful, and some of the front teeth are more or less hinged, so as to be capable of being bent back towards the throat. Of the few specimens known most have been found floating dead on the

Chias-
modon.

surface of the ocean, with the body highly distended by a fish as large as or even larger than the *Chiasmodon* itself, so that the latter appears to be spread out over the top of a bag containing the swallowed fish. The explanation offered is that the *Chiasmodon* is extremely voracious and will attack a fish as large as itself. When so large a prey has been swallowed, decomposition proceeds faster than digestion, and the gases generated cause the fish to rise out of its normal depth in the ocean, and as it rises through successively higher strata the gases expand and carry the body upwards more rapidly than before, and so the fish comes to float at the surface, dead.

Barracuda.

The Sphyrænidæ or Barracudas are long, slender, swift and voracious fishes, with powerful teeth, developed in sockets. They are found in nearly all seas of the temperate and tropical regions, often also in estuaries. Some of the tropical species, such as *Sphyræna agam* (460), *Sphyræna obtusirostris* (462, skull, showing teeth in sockets), and *Sphyræna commersonii* (1019, Table-case 39, 5 ft. 1 in. long), grow to six feet and are dangerous to persons bathing, more so than sharks because less readily frightened away. They will even make savage bites at the paddles of a canoe. The anterior dorsal fin is supported by spines and is well separated from the second or soft dorsal; the anal fin is opposed to the latter; the scales are cycloid and in regular series; there is no muscular gizzard such as occurs in the Mulletts. The flesh of the Barracuda is good, but it is poisonous at certain seasons, particularly in the West Indies.

Stromateidæ.

The Stromateidæ (e.g. 464) are a group of small fishes with short, compressed bodies, smooth, small scales, regular in arrangement, and usually extending over the cheek and bases of the median fins. The dorsal and anal fins are much extended, each with a few, feeble, crowded spines in the front portion. The number of vertebræ is unusually large, the jaws and teeth are feeble. The most distinctive feature of the Stromateidæ is the possession by the œsophagus of a pair of lateral sacs, the interior of which is beset with papillæ bearing small teeth. The young swim freely near the surface of the open ocean, feeding on pelagic crustaceans and the fry of fish, the adults, in many cases at least, are inhabitants of the deep sea. The Black-fish or Black Ruff,

Centrolophus niger, 465, of European seas is occasionally, but rarely, caught off Britain, as also is the Rudder-fish, *Lirus perciformis*. *Stromateus fiatola*, 464, the 'Fiatola' of the Italian fishermen, is an excellent food-fish of the Mediterranean. *Nomeus gronovii*, 466, a little fish about three inches long, widely distributed and common in the Gulf of Mexico, is found sheltering from its enemies among the long streamers of the Portuguese Man-of-War (*Physalia*), from which it enjoys a remarkable immunity. As many as ten of these fishes may be found swimming about beneath a large *Physalia*.

The remarkable deep-sea fish *Tetragonurus* (463) is allied to the Stromateidæ, as is shown by the structure of the mouth, the dentition, and more particularly the occurrence on each side of the œsophagus of a muscular sac studded internally with rather soft papillæ. There is but a single species, *Tetragonurus cuvieri*, sometimes called the Square-tail. It occurs in the Atlantic, Mediterranean, and the South Pacific, but is rare; it is poisonous as food; it feeds on jelly-fish, and probably lives in the depths of the sea by day and comes to the surface at night to feed. The young are said to live in the pharyngeal cavity of large Salps.

Tetra-
gonurus.

The Climbing Perch, *Anabas scandens*, 468, is so called because it is able to climb a sloping bank, to travel over land, and, it has been stated, to climb trees, by means of the stout, backwardly sloping spines of the anal and pelvic fins and of the gill-cover, which is very movable. The fish holds on to the ground by the opercular spines, bends its tail and inserts its anal spines; it then straightens the body and causes the opercular spines to move forward over the ground, and then repeats the whole operation. The fish wriggles along thus on its side at a fairly rapid rate. The Climbing Perch can live a long time out of water; above the gills are a pair of large cavities, opening downwards, and divided up by thin, scroll-like plates of bone covered with delicate and highly vascular mucous membrane, by which air is breathed. The air is taken in through the mouth, and is expired through the mouth, not through the gill-openings. The Climbing Perch is a fresh-water fish of India, Burmah and Malay; some species of *Anabas* occur in Africa.

Climbing
Perch.

The Snake-head, *Ophiocephalus striatus*, 467, of the grassy swamps of China, India and the Philippine Islands, resembles

Snake-
head.

Anabas in its ability to survive long drought. It has an accessory suprabranchial cavity for aerial respiration, but the cavity is not filled up by a scroll-like labyrinthic organ as it is in the Climbing Perch. The Snake-head differs from *Anabas* also in having cycloid instead of ctenoid scales, and in having no spines to the fins. It has been naturalised in western North America, where it is known as the China-fish, the parental forms having been introduced from China.

GADIFORMES (Cod-fishes, &c.).

Gadi-
formes.
Wall-
case 11.

Included in the suborder Gadiformes are the Cod and its allies, and the Macrurid fishes. The pelvic fins, if present, are set far forward, either below or in front of the pectorals. There are no spinous fin-rays in any of the fins (except the first dorsal fin-ray of some Macrurid fishes). The tail-fin is symmetrical, the vertebral axis is not uptilted. The parietal bones are reduced and are separated by the supraoccipital; the pro-otic and exoccipital bones are separated by the opisthotic, which is large.

Macrurus.

The Macruridæ (e. g. *Macrurus*, 472, and fig. 64), called in America Rat-tails or Grenadiers, are entirely confined to the deeper

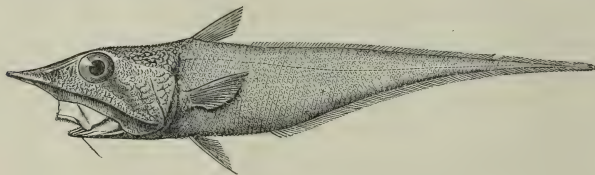


FIG. 64.—A Deep-sea Fish, *Macrurus parallelus*.

parts (120 to 2600 fathoms) of the great oceans, and are common in the North Atlantic and Pacific. There are two dorsal fins, the first short-based, the second of great horizontal extent. The anal fin is also extensive, and, like the second dorsal, reaches to the hind extremity of the body, which tapers off to a filament. The scales are usually rough and spinous. The eyes are large, the mouth is small, and there is usually a single barbel on the chin. The pelvic fins are situated below the pectorals and have 7 to 12 rays. In some of the genera, such as *Macrurus*, the mouth is inferior and the snout conical and prominent and

supported by the enlarged nasal bones. In the less specialised forms the mouth is terminal, the scales are cycloid, and the dorsal fin is more or less continuous.

In the Gadidæ or Cod-like fishes the mouth is large and terminal, bounded above by the premaxillary bones only; the cheek-plates are much reduced, the gill-openings wide. In most the suture between the two frontal bones has disappeared. The pelvic fins are anterior to the pectorals (jugular position). The dorsal fin occupies nearly the whole of the back, and in many cases is divided up into two or three portions; the anal fin in like manner may be divided into two parts. The scales are small and cycloid. The "Cod-fishes" and their allies chiefly inhabit the north temperate and arctic seas, but the abyssal forms are of wide distribution. The Burbot (*Lota vulgaris*, 483) occurs in, and is confined to, fresh water. Many of the Gadoid fishes are valued as food and form the basis of an important fishing industry in European and North American seas, and a staple food of the people in some of the northern lands. Gadidæ.

The Cod, *Gadus morrhua*, 476, is a most important food-fish; the quantity landed annually at British ports alone is according to the latest returns not less than 2,000,000 cwts., the value of which is over £1,000,000. The Cod grows to a length of four feet and may attain a weight of a hundred pounds. It is a northern fish and does not occur nearer the equator than 40° N. lat. The British forms are greenish or brownish olive, with numerous spots, but the more northern forms are darker in colour and without or with fewer spots. Cod are caught, by means of lines and trawls, at any depth down to 120 fathoms. The fishes are kept in ice and sent to market as fresh fish, or they are salted. Most of the salted Cod consumed during the Lent season comes from Newfoundland. The liver of the Cod yields a readily digested oil of great value in the treatment of emaciated patients, those suffering from lung complaints benefiting especially. The preparation of cod-liver oil is an important industry on the Norwegian coast; the name of the oil must not be taken too literally, for the livers of all species of *Gadus*, not the Cod only, are used as a source of it. Cod.

The tail of the Cod, although externally similar to that of most

Teleostean fishes, e. g. that of the Salmon, being externally symmetrical above and below the middle, is internally symmetrical also. The vertebral axis is not uptilted, and the hæmal spines of the last few vertebræ are not expanded into hypural bones (477). The fin-rays of the lower part of the tail-fin are carried by inter-spinous bones, and it is probable that the true caudal fin has atrophied, and has been replaced by a continuous series of fin-rays belonging to the dorsal and anal fins.

In the Cod and other species of *Gadus* there are three separate fins on the back, and two anal fins between the anus and the tail-fin. Of the European species of *Gadus* other than the Cod the most important are the Haddock (474), Whiting (479), Pollack (478), Coal-fish (475), Bib (480, skeleton), Poor-cod (481), and Poutassou.

Haddock. The Haddock, *Gadus aeglefinus*, 474, is distinguished from the Cod by its black lateral line and the blackish patch above the pectoral fin. It attains a length of three feet in the arctic latitudes, although it is smaller on the southern coasts. Much of the fish is eaten fresh, but it is most in favour in the smoked and dried condition.

Whiting. The Whiting, *Gadus merlangus*, 479, extends from Norway to the Mediterranean, and is abundant in shallow water round all the coasts of Britain and Ireland. The Pollack, *Gadus pollachius*, 478, is found in rocky localities along the Atlantic coasts of Europe from Norway to the Mediterranean. In the British Isles it is commonest off the Devon, Cornish and Irish coasts. It is of more interest to the sea-angler than to the regular fisherman.

Pollack. The Pollack, *Gadus pollachius*, 478, is found in rocky localities along the Atlantic coasts of Europe from Norway to the Mediterranean. In the British Isles it is commonest off the Devon, Cornish and Irish coasts. It is of more interest to the sea-angler than to the regular fisherman.

Hake. The Hake, *Merluccius vulgaris*, 473, can be distinguished from the species of *Gadus* by its having two dorsal fins and one anal fin. There is no barbel on the chin; the frontal bones are not fused together as in the Cod. The Hake is a large fish, growing to four feet in length; it is voracious, with strong teeth, and follows the shoals of Mackerel, Pilchards and other migratory fish. The flesh is soft and of fair quality, most of it is preserved as "Stock-fish."

Ling. The Ling, *Molva vulgaris*, 485, is a northern but wide-ranging fish; it is fairly common around the British Isles. Most of the Ling caught are cured and dried.

The Burbot or Eel-pout, *Lota vulgaris*, 483, is a fresh-water member of the Cod family. The skin is unpleasantly slimy, and has small scales which are embedded so as to give the surface a pitted appearance. The colour varies considerably in different localities. There is a single barbel which hangs from the middle of the chin, and from which the French name Barbotte and the English Burbot, meaning "bearded," have arisen. As in the Ling there are two dorsal fins, the base of the second covering half the entire length of the animal and being balanced below by the anal, which, however, is shorter in the base. In England the Burbot grows to 1 or 2 feet and attains a weight of 2 or 3 lbs., but in the Rhine it grows much larger, sometimes weighing as much as 30 lbs. In Alaska it grows to 60 lbs., such a fish being not less than 6 feet long. The Burbot is of a retiring disposition, and in the daytime lurks in holes and beneath stones. It is largely a nocturnal feeder and subsists on small fishes. Its flesh is said to be excellent, but it shares with the Pike and Barbel the disadvantage of harbouring the young form of a tape-worm (*Bothriocephalus*) which can complete its growth in the human body if it is not killed in the process of cooking. The Burbot is widely distributed over Central and Northern Europe, extending eastward to India, and is also found in North America. In England it is very local; it occurs in the Trent and other rivers of the eastern part of England, but not in the Thames.

Burbot.

While in most of the Cod-like fishes there is a single barbel, in the Rocklings the number is increased. The commonest British Rocklings are the Three-bearded Rockling, *Motella tricirrhatta*, 486, and the Five-bearded Rockling, *Onus mustela*, 487; small fishes, with the front dorsal fin reduced to a narrow, delicately-rayed fringe, more or less concealed in a longitudinal groove.

Rockling.

The Greater Fork-beard, *Phycis blennioides*, 482, though common in the Mediterranean and in the North Atlantic, is only occasionally caught off the British coasts; the exhibited specimen was caught at Fleetwood, in Lancashire. There is a single barbel on the chin, and the pelvic fins are reduced each to a single long ray, forked at the extremity, looking like a forked barbel and probably serving the same purpose.

Fork-beard.

The series of "Cod-fishes" on exhibition ends with the Torsk,

Torsk.

Brosmius brosme, 488, a large fish of both shores of the North Atlantic, with the dorsal and anal fins not divided, and with the tail-fin rounded behind, and the Trifurcated Hake, *Raniceps trifurcus*, 489, a small fish of northern Europe, with a large, broad, depressed and somewhat frog-like head.

ACANTHOPTERYGII.

Spiny-fin
Fishes.
Wall-
case 12.

The suborder Acanthopterygii is a very large one, including the Perches, Mackerels, Flat-fishes, Gobies, Blennies and Gurnards. The majority of marine fishes belong to this suborder. Except in a few cases the foremost rays of the dorsal and anal fins are spinous and hard, instead of being jointed and flexible or "soft." The upper border of the mouth is supported by the premaxillary bones, to the exclusion of the maxillæ, which are toothless. The right and left parietal bones are separated. The gill-opening is in front of the pectoral fin and is usually large. The pelvic fins are forwardly placed and their skeleton consists typically of one spine and five soft rays; the pelvic bones are usually firmly connected with the clavicular arch.

Perciformes (Perches).

The Perciformes constitute a large division of the Acanthopterygian fishes and consist chiefly of marine forms. The pelvic fins are thoracic in position, *i. e.* are about as far from the snout as are the pectoral fins. The stalk of the tail is rarely much constricted, and the rays of the caudal fin are not strongly forked at the base as they are in the next division (Scombriformes). The division is of some antiquity, Berycoid and Serranid fishes being found in Upper Cretaceous strata. The existing members are widely distributed, but are absent from the arctic and antarctic seas. The various families comprising the division Perciformes are distinguished the one from the other by the number of gills present, the coalescence or distinctness of the two lower pharyngeal bones, the presence of two nostrils or one on each side, the number of spines and soft rays in the various fins, the presence or absence of a shelf of bone projecting from the suborbital bones to support the eyeball, the insertion of the ribs either on transverse

processes of the vertebræ or directly on the centra, and the characters of the post-temporal bone, the teeth, and the barbels.

The Berycoid fishes (e. g. *Beryx splendens*, 493, Wall-case 12) are the most ancient and generalised of the Acanthopterygian fishes, and were richly represented in the Upper Cretaceous by several genera (e. g. *Hoplopteryx*, fig. 65) which are closely related to, if not identical with, the existing genera. They have a short

Beryx.

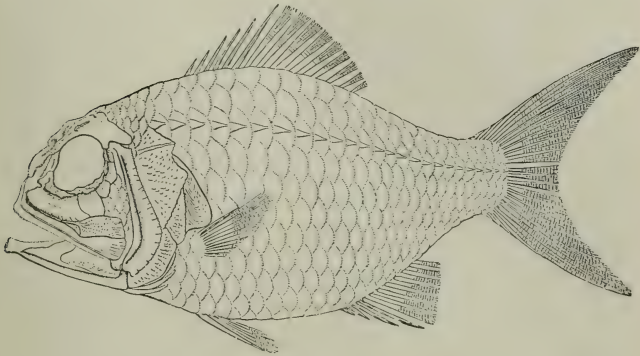


FIG. 65.—Restoration of an extinct form of Beryx, *Hoplopteryx lewesiensis*.
(After A. S. Woodward.)

body; the pelvic fins have an exceptionally large number of fin-rays, 6–13 soft rays and one spine. The eyes are large, the cleft of the mouth is oblique, the jaws have small teeth, the bones of the gill-cover are more or less armed with spines. In the septum or partition between the two eyeballs is a bone, the orbitosphenoid, which is present in the more primitive Teleostean fishes such as the Herrings and Salmons, but is wanting in the Perches and Mackerel-like fishes.

Some of the Berycoid fishes (e. g. *Beryx* and *Holocentrum*, 496) have a persistent pneumatic duct to the air-bladder, and this again is evidence of the Berycoids constituting a connecting link between the Physostomous fishes such as Herrings and Salmons and the typical Acanthopterygians such as the Perches. In the recent forms and in some of the extinct forms the tail is deeply cleft, and

the scales are ctenoid and uniform. All are marine, except the little Pirate Perch, *Aphredoderus sayanus* of North-American fresh waters; some, like *Holocentrum*, live at the surface of the sea; others, like *Beryx*, occur only at great depths and are typical members of the deep-sea fauna. The Berycoid fishes do not attain a large size; the exhibited specimen of *Beryx splendens* (493) is an exceptionally large one. Specimens of *Beryx* are occasionally brought to the London markets, not so much from their food value as the fact that their bright red colouring makes a fine display on the fishmonger's slab. The specimens come mostly from the Bay of Biscay and the coast of Portugal.

Myri-
pristis.

Myripristis (495), like *Holocentrum*, lives at the surface in tropical seas, near the coast; it is esteemed as food. The fishes of the genus are very pugnacious and always ready to quarrel with their own kind. In Hawaii the natives take advantage of this trait to catch the Uu (*Myripristis murdjan*). Having obtained one alive by a net or other means, they attach a string to it and put it back into the water in front of the crevices in the rocks in which these fishes lurk. The other fishes soon come out to fight it, and the crowd is brought to the surface of the water by slowly drawing in the string; a net is passed cautiously beneath and the whole crowd captured.

The Monocentridæ are a small family containing a single genus, *Monocentris*, 500, differing from the Berycidæ in the scales being larger and stouter, forming a rigid carapace, in the pelvic fins being reduced to a single spine with 2 or 3 soft rays, and in the stoutness of the spines of the dorsal fin. The Japan species (500) is sometimes called the Pine-cone-fish.

The Centrarchidæ are fresh-water fishes of small size, rarely exceeding six inches in length, common in North America. The principal forms are the Sun-fish (*Lepomis*), the Black Bass (*Micropterus*), acclimatised in some parts of continental Europe, and *Kuhlia* (501) of Polynesia. They are all valued as food.

The Lobotidæ, a very small family containing two genera only, *Lobotes*, 505, and *Datnioides*, 504, are allied to the Centrarchidæ. *Lobotes* is a widely distributed marine form, *Datnioides* occurs in the rivers and estuaries of the Ganges and the East Indies.

Archer-
fish.

In the Toxotidæ or Archer-fishes (e. g. *Toxotes jaculator*, 506)

the body is rather short and laterally compressed, with cycloid scales of moderate size, a pointed snout, with large gape and a projecting lower jaw. The dorsal fin is set far back and has five strong spines; the anal fin has three spines. The scales extend over the soft portions of both dorsal and anal fins. The Archer-fish is a fresh-water fish of the East Indies, Queensland and New Zealand. It is so called because of its habit of rising to the surface and discharging from its mouth a drop or jet of water upon an insect which it perceives resting on a leaf or twig overhanging the water, in order that the insect may fall into the water and become an easy prey. The fish continues this entertaining practice in captivity, and the Malay people keep the "Ikan sumpit," as they call it, for purposes of amusement.

The Perches (family Percidæ) are fresh-water fishes of the northern hemisphere, with the spinous dorsal fin longer than the soft dorsal, and the latter not much more developed than the anal fin; the anal fin has one or two spines only. The Perch, *Perca fluviatilis*, 507, well known to anglers by the conspicuous vertical dark bars extending from the back some distance down the sides, is a bright-looking fish, rather rough to the touch owing to the fine serration of the free edges of the ctenoid scales. Although the specific name of the Perch is *fluviatilis*, the fish is more at home in lakes than in rivers; in fact the Perch cannot spawn in places where there is any considerable current. Perches are essentially gregarious fish, swimming about and seeking their prey in shoals, but as they grow old they become more solitary in their habits. It is curious to note that large and small Perch do not associate together; large Perch, in fact, do not hesitate to devour the young of their species. The Perch is a good fish for the table, its flesh being firm, clean and white, but most of the specimens caught by anglers are discarded, and there is no demand for such fish in the British markets. In Russia, on the other hand, the Perch is an important article of diet. The size of the Perch varies much in different waters, depending largely on the relative abundance or scarcity of food. Perch up to 3 lbs. in weight are not infrequently caught in Britain; Frank Buckland vouches for the capture of genuine Perch of $4\frac{1}{2}$ lbs. A few cases are recorded of fish weighing 7 or 8 lbs., but there is a suspicion

Perch.

that these records may refer to the Sea-perch or Bass (*Morone labrax*, 511, Wall-case 13), which is sometimes found in tidal rivers, but can be readily distinguished by its having 8 to 10 spines in the front dorsal fin, whereas the true Perch has 14 to 16.

Pope.

The Pope, or Ruffe, *Acerina cernua*, 509, is an obscure little fish, found in England, but not in Scotland or Ireland, common in Scandinavia, Russia and Siberia. In England it scarcely reaches six inches in length, but in Siberia it grows much larger. It differs from the Perch in the incomplete separation of the spinous dorsal fin from the soft dorsal, and in the border of the preoperculum being armed with 10 or 12 spines and the operculum with a single spine. It is not known how the name "Pope" came to be applied, but the fish has suffered a great deal of persecution in consequence of its unfortunate appellation, for during the Protestant movement in England, when hatred of everything savouring of Roman Catholicism was rife, the people of the midland towns used to catch the unoffending fishes, fix a cork on the dorsal spines of each, and put them back into the canal or stream until, as Frank Buckland describes it, the surface of the water for miles was covered with bobbing corks. Hampered by the corks and consequently unable to catch any food, the unhappily-named fishes were left to die a lingering death.

Sandra.

The largest fishes of the family Percidæ are the Pike-perches,

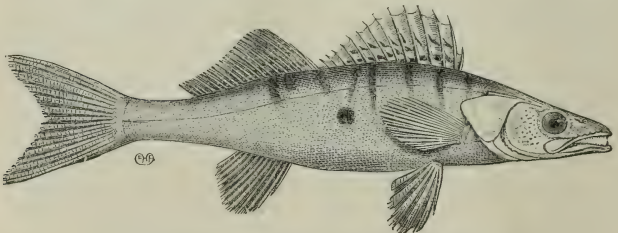


FIG. 66.—Pike-perch, *Lucioperca sandra*.

such as the Sandra, *Lucioperca sandra*, 508, and fig. 66, which is a common fish in the lakes and rivers of the continent, although absent from Britain, and grows to a length of three or four feet in

favourable situations and may weigh as much as 25 lbs. It is one of the most esteemed of fresh-water fishes. It has been proposed to naturalise the fish in British waters, but its voracity renders it an undesirable inhabitant of streams where Trout and other valuable fishes are kept.

The Sea-perches constitute a very large family, the Serranidæ, widely distributed around the shores of all tropical and temperate seas, while a few are found in the depths of the ocean. They differ from the Percidæ in having a ledge of bone projecting internally from the second suborbital bone to support the eyeball, and in other osteological characters. Some of the Sea-perches attain to a great size, witness the *Epinephelus lanceolatus* in Table-case 40, which is 7 feet 3 inches long, and the *Stereolepis gigas* in Table-case 46, which is 5 feet long. The species of these large fishes are rather difficult to determine, and the name Jew-fish

Sea-perches.
Wall-case 13.

Jew-fish.

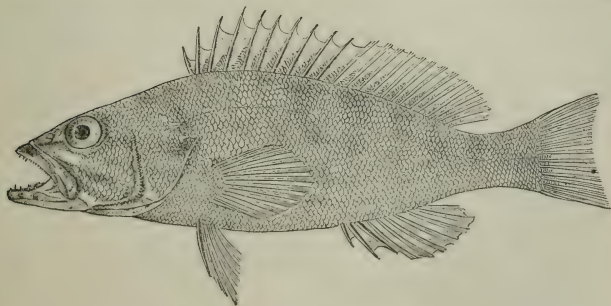


FIG. 67.—A Sea-perch, *Serranus cabrilla*.

(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.)

is applied indiscriminately to any large specimens of *Stereolepis* or *Epinephelus*. The specimen of *Epinephelus cernioides*, 1103, although not so large as the two fishes just mentioned, is of interest in having been caught in British waters, namely, off the coast of Loo in Cornwall. As a general rule these large fishes are of a uniform dull brown or greenish colour, in striking contrast with the spotting and banding in the young—compare, for instance, the young of *Epinephelus lanceolatus*, 523, Wall-case 13,

with the adult in Table-case 40. *Epinephelus* is a large genus, and many of the species do not attain to a greater size than those shown in the Wall-case 13.

The Sea-perches of the genus *Serranus* are interesting because some of them, such as the Comber, *Serranus cabrilla*, 524, and fig. 67, are hermaphrodite, regularly so and not as an exceptional circumstance. A few enter brackish and fresh water.

Bass.

The Bass, *Morone labrax*, 511, is a form of Sea-perch common on the British coasts, appearing in shoals in the shallow seas and estuaries between June and September. It is a voracious fish with a remarkably large stomach, and it received from the ancient Romans the appropriate name of "Lupus" or Wolf. The Greeks and Romans esteemed the Bass very highly as a table-fish, but at the present day the fish does not enjoy high repute. This is the fish that Aristotle declared to be the most cunning of fishes, because when surrounded by the net it digs for itself a channel through the sand by which to escape. Specimens of 8 or 10 lbs. are not uncommon, and authentic cases of Bass of 22 to 28 lbs. are on record.

The Stone-bass, *Polyprion americanus*, 513, is a fish found in the open ocean; it is sometimes called the Wreck-fish because it is often met with in the neighbourhood of floating timber, to which it is attracted by the Barnacles, &c. upon which it feeds.

Murray-cod.

Occurring plentifully in the Murray River and other rivers of South Australia is the Murray-cod, *Oligorus macquariensis* (514, Wall-case 12, floor), a fish which attains to a length of more than three feet and a weight of 100 lbs. It is valued on account of the excellent flavour of its flesh, as also is the Hapaku, Hapiku or Hapuku, *Oligorus gigas*, of the coasts of New Zealand. Another genus of large fishes is *Lates*, represented by *Lates calcarifer*, 530, of the coasts and estuaries of India, South China, and North Australia, and a skeleton of *Lates niloticus*, 55 inches long (Table-case 33), a well-known fish of the Nile and other rivers of tropical Africa. *Mesoprion* and *Genyoroge* are large genera, represented in the exhibited series by specimens 541-546 and 537-540. *Mesoprion bohar*, 544, the "Mumea" of Samoa, is poisonous as food. *Genyoroge sebæ*, 540, is called the "Government" Bream by the Australian fishermen because of a red-brown mark on the

side of the body which resembles the government "broad-arrow" mark. The fish grows to a weight of several pounds, is much esteemed for the table, and is forwarded to market in a smoked condition. *Aprion virescens*, 536, the "Uku" of Hawaii, is a green, long-bodied fish, widely distributed through Polynesia, and one of the best food-fishes of that region.

Histiogaster is a genus of rather aberrant fishes of Japan and Australian seas, having a strongly compressed body with very small scales, and a small mouth set at the end of a much produced snout. The teeth are fine, close-set, and equal, and the palate is toothless. *Histiogaster recurvirostris*, 550, is called the "Bastard Dory."

Closely allied to the Serranidæ are the Pseudochromididæ, in which the spines of the dorsal and anal fins are feeble and few. The fishes are marine and of generally wide distribution; most of them are small, e. g. *Latilus* (554) and *Malacanthus* (555). The Tile-fish, *Lopholatilus chamaeleonticeps*, is one of the largest of the family, and is restricted in its distribution, occurring only in moderately deep water (70-130 fathoms) in the American part of the North Atlantic. It is very brightly coloured; the triangular "fatty fin" on the back of the head is remarkable, and is characteristic of the genus *Lopholatilus*. Tile-fish.

The Tile-fish was first caught in 1879 off Nantucket Island, several hundred specimens being obtained. It was found to be an excellent table-fish and was expected to become a regular article in the American fish markets. For three years it was fairly common and many thousands were captured.

In March 1882 a vast destruction of the Tile-fish took place; millions of the dead fish were found floating on the surface of the ocean over an area of some 5000 to 7000 square miles. Prof. Verrill has pointed out that at the bottom of the region in question there is a band of temperate water (48° to 50° F.) between the Arctic current on the one hand and the cold deep sea on the other, and that in this temperate band the Tile-fish live and breed. He suggests that the heavy gales of the early part of 1882, and the displacement of much shore ice over the area, caused such a chilling of the warm tract of water as to kill off the fishes living in it, whose dead bodies were thus scattered far and wide.

After the wholesale destruction of 1882 it was feared that the Tile-fish had become extinct, but in recent years (since 1892) specimens have been caught in fair numbers at the usual depths of 70 or more fathoms and in the original district, namely around 40° N. lat. and 72° W. long. This history of the destruction of the Tile-fish is important as being one of the very few cases in which we know of the almost complete destruction of a species by natural causes—that is to say without the intervention of man as a hunter or as a carrier of disease.

Band-fish. Resembling the last family in the feebleness of the spines, of which there are only three in the dorsal and one in the anal fin, are the Cepolidæ or Band-fishes, e. g. the *Cepola rubescens*, 556, a fish common in the Mediterranean and sometimes taken on the British coasts. It grows to about 18 or 20 inches, and is of a bright red colour. The body is long and band-like, reminding one of the Ribbon-fishes (Wall-case 19), with which at one time the Cepolidæ were classed. The dorsal and anal fins extend nearly the whole length of the body.

The Hoplognathidæ of the coasts of Australia, Japan, and Peru, with the single genus *Hoplognathus* (557), have the spinous portion of the dorsal fin well developed; the body is compressed laterally and covered with very small ctenoid scales. The chief distinguishing feature is the coalescence of the teeth to form a kind of beak with a sharp edge. The Sillaginidæ, another small family with a single genus, *Sillago*, are small fishes related to the Meagres of the next family, the Sciænidæ, from which they differ in the greater length of the base of the anal fin and the presence of teeth on the vomerine bone. There is a separate spinous dorsal fin, but it is short-based as compared with the soft dorsal. *Sillago ciliata*, 559, is known as the "Whiting" in Australia, where the true Whiting (*Gadus merlangus*, 479, Wall-case 11), a fish of northern distribution, does not occur. The misapplication of popular names in the colonies is due to the early settlers, who, coming across an animal new to them, had only three courses open to them, to accept the name by which it was known to the natives, to invent a new name for themselves, or to apply the nearest or least inappropriate name already existing in their vocabulary, and in almost all cases they preferred to follow the last course. Thus, they called the birds Sparrows and Robins and Thrushes, and the

Colonists' Names.

fishes Trout and Herring and Whiting, and their children and grand-children, who had no opportunity of knowing what the real Trout and Whiting were like, innocently adopted the names used by their elders. The ultimate result is that modern colonial people visiting England for the first time express surprise at the difference which exists between their own animals and the similarly-named animals of this country, and rather than rename their own, they allude to our British forms as the "English Trout," the "English Whiting," and so on.

The *Sciænidae* are fishes common near the sandy shores of all warm seas, with the soft dorsal much more extensive than the spinous dorsal and the anal fins, the pelvic fins thoracic in position, and with no teeth on the palate. Some of the fishes attain to a great size, and most are edible. *Sciæna diacanthus* is a common fish on the coast of the East Indies, ascending the rivers for a great distance from the sea. The specimen of this species in Table-case 48 is 6 feet 3 inches long. One of the European species, *Sciæna aquila*, the Meagre (1101) has an extremely wide range, specimens having been caught on the British coast, the Cape, and Southern Australia. *Corvina* (562) differs from *Sciæna* in having the second ray of the anal fin strong. Sciænidae.

In *Umbrina* the snout overhangs the mouth and there is a short barbel under the chin. The *Umbrina* or Ombre, *Umbrina cirrhosa*, 566, is an important food-fish of the Mediterranean, and in the delicacy of its flavour ranks high; it was well known to the ancients. *Pogonias chromis*, 564, is called the Drum or Big Drum because of the extraordinary sounds which it produces, drumming sounds which can be heard by persons in vessels lying at anchor on the coasts of the United States, where the fishes abound. The sounds are either produced by the clapping together of the pharyngeal teeth, which are strongly developed, or else by the fishes beating their tails against the bottom of the vessel in order to free themselves from the parasites that infest their skin. The Drum grows to a length of four feet and a weight of 100 lbs. *Micropogon* (563) differs from *Pogonias* chiefly in that the pharyngeal teeth are conical instead of being flat-topped and adapted for crushing (see pharyngeal teeth of the Drum, 565). Meagre.

The *Gerridae* (e. g. *Gerres*, 574, and *Equula*, 575, Wall-case 14) are small, silvery fishes common in tropical seas and frequently Drum.

Wall-case 14.

Trum-
peter.

also in fresh water. The mouth is very protractile and descends when thrust out; the dentition is feeble, and the lower pharyngeal bones are fused together. The Latrididæ are a small family of southern fishes of large size, related to the Serranidæ on the one hand and the Haplodactylidæ on the other. The species of *Latris* are among the most important food-fishes of Australia and New Zealand. The Trumpeter, *Latris hecateia*, 576, grows to 50 or 60 lbs., and *Latris ciliaris*, 577, to 20 lbs. The Haplodactylidæ (e. g. *Haplodactylus*, 580, and *Chilodactylus*, 579) differ from the last in the anal fin being shorter, but agree with them in the pelvic fins being set relatively far back; they bear some resemblance to the Sparidæ, but differ in having the lower rays of the pectoral fin thickened and not branched. The Pristipomatidæ (*Pristipoma*, 581, and *Diagramma*, 586) is another family of no special interest.

The Sea-breams and Snappers belong to the family Sparidæ; they are coast fishes, widely distributed, and mostly carnivorous. The spinous and soft portions of the dorsal fin are continuous and nearly equal in extent; the lower rays of the pectoral fin are branched; the lower pharyngeal bones are separate. The genera of the family are distinguished the one from the other chiefly by the characters of the teeth. In *Chrysophrys*, 606, and other forms, such as *Sargus*, *Lethrinus*, *Sphærodon*, *Pagrus*, and *Pagellus*, which feed on hard-shelled crustaceans and molluscs, the hinder teeth are strongly developed as molars. In such genera as *Cantharus*, *Box*, *Crenidens*, *Dipterodon*, and *Gymnocrotaphus*, on the other hand, the teeth at the front of the jaw are moderately broad, cutting teeth, and there are no molar teeth.

Dentex vulgaris, 589, is one of the larger species of the genus. It is common in the Mediterranean, and is sometimes caught on the south coast of England. The Old-wife, *Cantharus lineatus*, 587, with numerous longitudinal bands on the sides of the body, is also sometimes found in the English Channel.

Sheep's-
head.

The Sheep's-head of the United States, 594, is the largest species of the genus *Sargus*; it attains to a weight of 15 lbs. and a length of three feet, and is highly esteemed on account of the excellence of its flesh; it is common in sandy bays from Cape Cod to Texas. Several species of *Sargus* occur in the Mediterranean

and the neighbouring parts of the Atlantic Ocean, and are popularly known as Sargo, Saragu, Sar, names derived from the word "Sargus," by which these fishes were well known to the ancient Greeks and Romans. In some of the Mediterranean species of Sparidæ hermaphroditism is of normal occurrence.

The well-known "Pagro" of the Mediterranean is *Pagrus vulgaris*, 596, an important food fish, found also off Madeira and the Canary Islands. The Snapper, *Pagrus unicolor* (fig. 68; Snapper. 597, skeleton) of the seas of Australia and New Zealand is considered very good eating, and attains a length of three feet and a

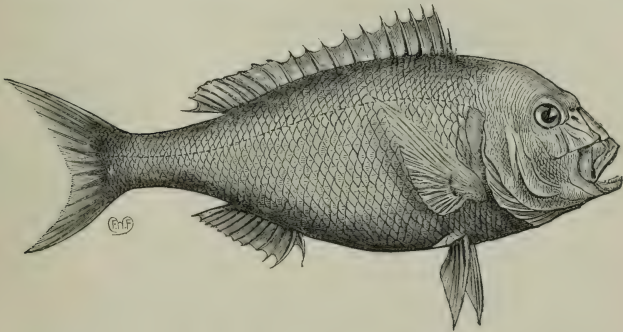


FIG. 68.—Snapper, *Pagrus unicolor*.

weight of 20 lbs. *Pagrus argyrops* of the coasts of the United States is an important food-fish, and is known as the Scup, Porgy, or Mishcup. Another species of *Pagrus* is the famous Red Tai (*Pagrus major*) of Japan, a crimson fish which is as much a national emblem of that land as the rising sun and the chrysanthemum.

The Gilt-head or Dorade, *Pagrus auratus*, 605, and fig. 69, is a Gilt-head. common food-fish of the Mediterranean, and is occasionally taken off the south coast of England. It was one of the fishes that were kept in captivity by the ancient Romans. The fish is called "Gilt-head" because of the brilliant golden spot, band, or crescent between the two eyes; the name Dorade, sometimes spelt Daurade, is clearly derived from the Latin "aurum," gold, and

refers to the same distinctive mark. The ancient Greeks called it "Chrysophrys," signifying "Golden-Eyebrow," a word which at the present day is employed to designate a genus of the Sparidæ to which at one time the Gilt-head was referred.

Sea-
bream.

The Sea-bream, *Pagellus centrodontus*, 602, is not in any way related to the Bream (349, Wall-case 8), which is a fish allied to

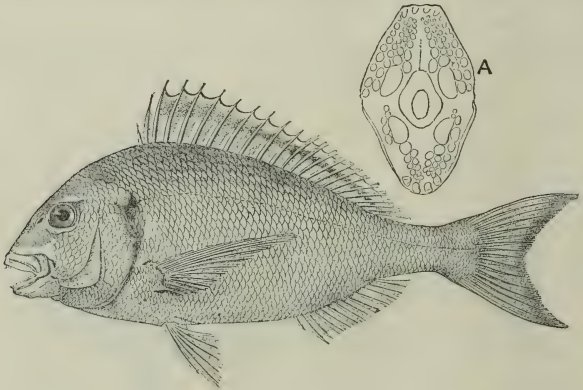


FIG. 69.—Gilt-head or Dorade, *Pagrus auratus*.

A, view of the widely open mouth showing the form of the teeth.

(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.).

the Carps. The fish that the fishermen of Cornwall and Devon call the "Chad" is a young Sea-bream, without the black spot at the front of the lateral line that distinguishes the adult. The Cape Sea-bream, *Pagellus lithognathus*, 601, is larger than the British and Mediterranean species.

The Red Mullet (family Mullidæ) have affinities with the last family, the Sparidæ, but can readily be distinguished by the pair of erectile barbels which project downward and forward when the fish is feeding on the sea bottom, but lie back in grooves when the fish swims about. The two dorsal fins are separated and short-based, and the spines supporting the anterior one are feeble. Most of the Mullidæ are tropical fishes, but the common Red Mullet, *Mullus barbatus*, 609, occurs in Europe. The Red Mullet has long been famed for the delicate flavour of its flesh. It was

Red
Mullet.

prized by the ancient Greeks and Romans, who paid extravagant prices for large specimens. The brilliant red colour of the skin which adds to the attractiveness of the Red Mullet as a table fish fades when the fish dies, but can be "fixed" by scaling the fishes directly they are caught, a process which causes the colour-cells or chromatophores to die in a fully expanded condition. Almost all the Red Mullet that finds its way to the London Markets is caught off the coast of Cornwall. The fish does not grow large, one of 15 inches in length and 2 lbs. or $2\frac{1}{2}$ lbs. in weight would be considered above the average. The Surmullet is by some authorities regarded not as a distinct species, but the female of the Common Red Mullet. *Upeneus* (610-612) is a tropical genus of wide distribution.

The Scorpididæ are fishes of tropical and southern seas, the most remarkable of which is *Psettus sebae* (614), in which the height of the body is greater than the length. The body is much laterally compressed; the dorsal and anal fins are long in the base and are almost covered over with scales. The Boar-fish, *Capros* Boar-fish. *aper*, 615, of the small family Caproidæ, is a fish of the Eastern Atlantic and Mediterranean, sometimes caught in the English Channel. The mouth is very protractile, the surface of the body is very rough to the touch owing to the scales being not merely ctenoid, *i. e.* with a comb-like free edge, but spiny.

The Chætodontidæ are tropical, marine fishes occurring in abundance in the neighbourhood of coral reefs. They are carnivorous, feeding on small invertebrates; most are of small size and some are of exquisite beauty of design and coloration. Yellow and black are the leading combinations; there is not infrequently a black band passing down across the eye and one or more striking black spots at the root of the tail or on the fins. The Chætodonts are sometimes called Butterfly-fishes from their brilliant coloration. The body is laterally compressed, the scales are small and extend on to the dorsal and anal fins. The teeth are close-set and minute and slender, whence the name of the family, signifying 'bristle-toothed.' The mouth is small and frequently is set at the end of a prolonged snout. The spinous and soft portions of the dorsal fin are continuous.

Chæto-
donta.

Chætodon (616-621) is a genus with many species. The fishes

are small and very active in their movements. *Chelmo* (622) differs from *Chætodon* in having the snout produced into a more or less long tube. The fish is said to throw a jet of water from its mouth so that it lights upon an insect resting upon a leaf and causes it to fall into the water, when the fish seizes it. The statement, however, has probably arisen from a confusion between this fish and the Archer-fish, *Toxotes jaculator* (506, Wall-

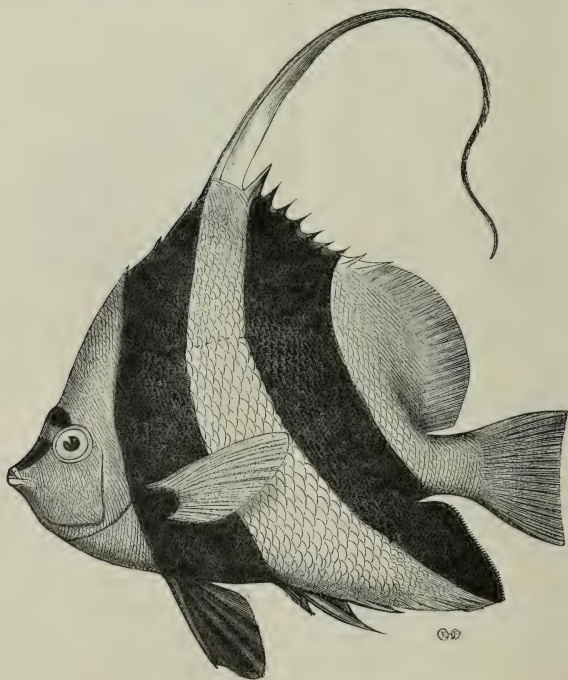


FIG. 70.—*Heniochus macrolepidotus*.

case 12), which is known to catch insects in this manner. The *Chelmo* is a salt-water fish, and it is highly improbable that it feeds on insects at all.

Heniochus macrolepidotus (623-624, and fig. 70) has the fourth

dorsal spine greatly elongated and thread-like; the colours vary in different specimens, although the arrangement of the light and dark bands is much the same in all (compare 623 and 624). These fishes are among the commonest in the tropical Indo-Pacific area.

The species of *Holacanthus* are known generally as Angel-fishes, the name being specially applied to *Holacanthus ciliaris*, 629; they are larger than those of *Chætodon* and not less bright in the coloration; they have a stout spine projecting backward from the preopercular bone which is wanting in *Chætodon*. They are all esteemed as food, particularly the *Holacanthus imperator* (627), which attains a length of 15 inches.

Angel-fish.

The genus *Pomacanthus* includes American fishes only; they are larger than the species of *Holacanthus*, and have about 10 spines in the dorsal fin instead of 14. The young are brightly coloured, frequently with yellow bands, and they differ among themselves considerably in their coloration; the adults are blackish. The Paru, *Pomacanthus paru*, 632, is a well-known fish of the West Indies.

In *Scatophagus* (633) and *Ephippus* (635) there is more distinction between the spinous and soft portions of the dorsal fin than in the majority of the Chætodonts, owing to the presence of a fairly deep notch, and the scales do not spread over the spinous portion; the preopercular spine is wanting. *Scatophagus argus* (633) is a common Indian shore fish, and is sometimes caught in the rivers. Old specimens of an Atlantic species of *Ephippus* (*Ephippus faber*, 635) show almost constantly bulbous enlargements of the frontal and supraoccipital bones (636), and sometimes also of the foremost neural spines. These swellings have been attributed to a diseased condition of the bones; whether or no this is the correct explanation, the right and left symmetry of the swellings, the constancy of their occurrence in old fishes, and the limitation of them to the bones above mentioned are features of interest.

The family Drepanidæ contains a single species, *Drepane punctata*, 637, occurring in the Indian Ocean and North Australian seas, closely related to the Chætodontidæ, but distinguishable by the very long, curved pectoral fins.

Surgeon-
fish.
Wall-
case 15.

The Surgeon-fishes, fishes belonging to the genus *Acanthurus*, are readily recognised by the single, sharp, lancet-shaped spine with which each side of the tail is armed. When at rest the spine is hidden in a sheath, when erected it is a most dangerous weapon, which the fish uses by lashing the tail to right and left (647, *Acanthurus chirurgus*, the Surgeon-fish proper; 650, *Acanthurus sohal*, which is mounted with the back towards the observer so that the spines may be the better distinguished; and 651, a skeleton of *Acanthurus lineatus*, showing the relation of the spine to the caudal vertebræ). The spines are absent in very young individuals. The young Surgeon-fishes are more circular in outline than the adults, and are more compressed and have no scales; they were formerly thought to be distinct fishes and were described under the generic name *Acronurus*.

The Acanthuridæ are herbivorous or partly carnivorous fishes, common in tropical seas in the neighbourhood of coral reefs; they are fairly closely allied to the Chætodontidæ (Wall-case 14) and lead on towards the File-fishes (Wall-case 20). The maxillary is fused with the premaxillary bone, the mouth is small and not protractile, the jaws have either bristle-like or incisor-like teeth; there are no teeth on the palate; the post-temporal bone is fused with the cranium. The scales are minute and rough, either ctenoid or spiny; the dorsal and anal fins are long-based, the dorsal has the spinous portion less developed than the soft portion and not separated from it. *Acanthurus lineatus* (of which a skeleton is shown, 651) is a poisonous fish, producing "Ciguatera" similar to that caused by eating the flesh of the File-fishes.

Unicorn-
fish.

Naseus, the Unicorn-fish, 643-645, and fig. 71, has usually two spines at the side of the stalk of the tail, one in front of the other, and these are not erectile as are those of *Acanthurus*. The name Unicorn-fish is applied because of a bony horn projecting forward above the mouth, sometimes two inches long in a fish of a length of 20 inches. This horn is continuous with the bones of the cranium (see skeleton 645), and is said to be used by the fish as it butts up against the coral. *Prionurus* (642) differs from *Naseus* in having a series of about six bony laminæ on each side of the tail instead of distinct spines.

The Teuthididæ (652-654) differ from the Acanthuridæ in the

pelvic fins having the inner and outer rays spinous, with three soft rays between. They are herbivorous and do not grow longer than 15 inches; they are confined to the Indo-Pacific Ocean.

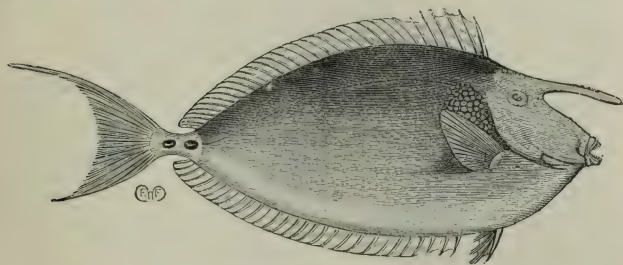


FIG. 71.—Unicorn-fish, *Naseus unicornis*.

In the Osphromenidæ there is much variation in the extent of the dorsal and anal fins, the spines of which are in some cases numerous, in others absent; the pelvic fins may have five soft rays, or the number may be reduced to one. A suprabranchial accessory organ of respiration is present; it is a paired organ situated in cavities behind the cranium. The fishes are confined

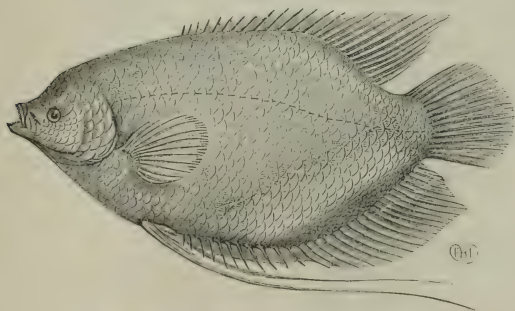


FIG. 72.—Gourami, *Osphromenus olfax*.

to the fresh-waters of Africa and Southern Asia. The Gourami, *Gourami*, *Osphromenus olfax*, 655, and fig. 72, is the largest fish of the family, and is one of the choicest food-fishes of the East. It is a

native of the Malay Archipelago, and has been introduced with success into India and Mauritius. The Gourami is essentially a vegetarian, but in a state of domestication is omnivorous and will consume meat, fish, frogs, insects, worms, and many kinds of vegetables, whence it has gained from the French colonists of Mauritius the name "porc des rivières," or "water-pig."

Fighting-
fish.

The Fighting-fish or Pla-kat of Siam (*Betta pugnax*, 656) is widely known as a pugnacious little fish. When the fish is quiet its colouring is dull, but in the presence of another of its kind it becomes excited in demeanour and the body shines with dazzling metallic colours, while the gill-cover is pushed out and forms a kind of black frill around the throat. The fish makes repeated darts at its antagonist, and the fight lasts until the fishes are tired. If the fight be interrupted by removing one of the combatants to another vessel, both become quiet and dull-coloured. The Siamese keep these fishes in glass bowls for the express purpose of watching the fights, and they will pit their favourite against another's, and stake large sums of money on the result of the fight.

Cichlidæ.

The Cichlidæ and the following family, the Pomacentridæ, have a single nostril on each side, whereas in all the other families of Acanthopterygian fishes there are two nostrils on each side. There are four gills on each side in the Cichlidæ, but only $3\frac{1}{2}$ in the three following families, the Pomacentridæ, Labridæ and Scaridæ. The two lower pharyngeal bones are fused together in the Cichlidæ, but less completely than in those three families. The Cichlidæ (657-658, and fig. 73) are fresh-water or brackish-water fishes of tropical and sub-tropical America, Africa and India. Our knowledge of these fishes has greatly increased of recent years in consequence of investigations in Lake Tanganyika, the fish fauna of which is largely made up of Cichlid, or as they were formerly called, Chromid fishes. The division of the family is based upon the characters of the spines and teeth, the latter exhibiting a wide range of variation. *Etroplus* (657) is an Indian genus; *Tilapia* (658) is African, and, like several other African Cichlids, is remarkable for the care with which the female parent guards the eggs from danger by carrying them about in the mouth. This habit is, curiously enough, shared by an entirely unrelated

fish, the *Arius* (376, Wall-case 10, floor), a fish of the family Siluridæ. In some of the American forms, such as *Cichla*, the

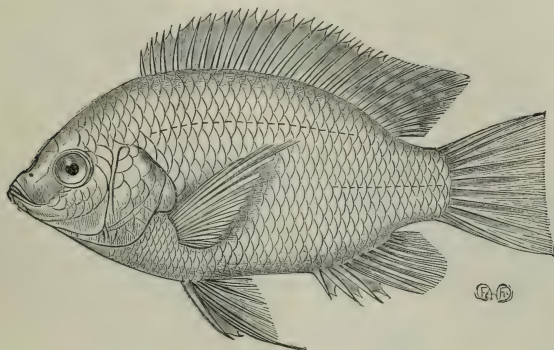


FIG. 73.—Bulti, *Chromis niloticus*.

males develop on the top of the head a hump which disappears after the breeding season.

The Pomacentridæ (662–666) are small fishes (see *Dascyllus*, fig. 74) intermediate in character between the Cichlidæ and the

Coral-
fishes.

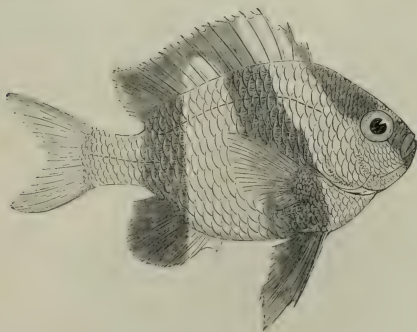


FIG. 74.—*Dascyllus aruanus*, nat. size.
(From Günther, "Study of Fishes.")

Labridæ, occurring in warm and tropical seas, frequently of brilliant coloration, and living in the neighbourhood of coral reefs.

The species of *Amphiprion* (662) are among the smallest. Some of the Australian forms are of interest because of their habit of associating with species of giant Sea-anemone (*Discosoma*). On pushing a stick into the mouth orifice of one of these Sea-anemones there almost invariably dart out two or three of the little fishes, which return into the interior of the anemone when the disturbance is over.

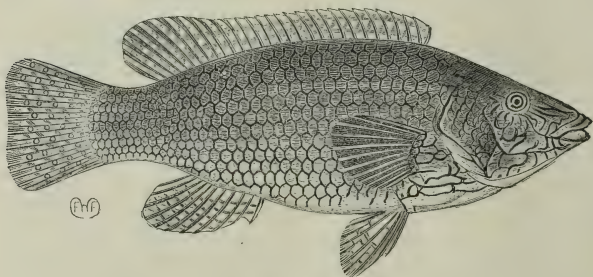


FIG. 75.—Ballan Wrasse, *Labrus maculatus*.

Wrasses. The Wrasses (family Labridæ, 667–692, and fig. 75) have the lower pharyngeal bones completely fused (673, and fig. 76), and

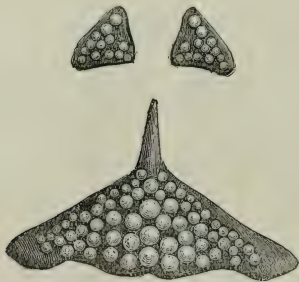


FIG. 76.—Upper and lower pharyngeal bones of the Ballan Wrasse, *Labrus maculatus*.

bearing conical or tuberculate teeth; the front teeth of the jaws are conical, the lateral teeth more or less coalesced at the base,

the palate without teeth. The fishes have thick, fleshy lips (whence the German popular name "Lippfisch"), and a slimy skin with cycloid scales.

The Labridæ are of wide distribution, occurring among the rocks and sea-weed of the coasts of all tropical and temperate seas. They are good eating, although the flesh is too soft and glutinous to suit some palates; they have no great commercial value and only find their way to certain markets. The colours are brilliant and vary considerably in different individuals of the same species, and in many cases there is a regular difference in colouring between the male and female during the breeding season. In the Cuckoo or Striped Wrasse, for instance (*Labrus mixtus*, 668), the male usually has blue streaks or a blackish band along the body, while the female has two or three large black blotches across the back of the tail. The male loses his bright colours in the winter, and three dark spots similar to those of the female, but fainter, then become apparent. The female was formerly supposed to be a distinct species from the Cuckoo Wrasse and was called the Three-spotted Wrasse. The Wrasses proper (genera *Labrus*, *Crenilabrus*, *Ctenolabrus*, *Acantholabrus*) are confined to the seas of Europe and northern Africa. They build nests of masses of soft sea-weed, tightly crammed into rock crevices, with the large amber-coloured eggs evenly dispersed through the mass. Both sexes take part in the building of the nest.

Occurring commonly in rocky, seaweed-clad parts of our coasts, particularly the southern coasts, are, besides the Cuckoo Wrasse above mentioned, the Ballan Wrasse, *Labrus maculatus*, 670, fig. 75, a larger fish than the former, attaining a weight of 7 or 8 lbs.; the Gold-sinny or Corkwing, *Crenilabrus melops*, 676, rarely exceeding nine inches in length, a brownish or reddish fish with dark bands down the sides, and rings, sometimes with dark centres, on the fins, the female distinguishable by a black spot immediately in front of the tail fin; *Ctenolabrus rupestris*, *Acantholabrus palloni* and *Centrolabrus exoletus*, the last, known as the Rock-cook, being a more northern form than most of the Wrasses, occurring even on the coast of Greenland. *Julis vulgaris* (685) and *Julis giofredi* (686) are common Mediterranean fishes

occasionally found on the south coast of England; it has been stated that they are respectively the male and female of the same species of fish. *Lachnolaimus falcatus* (677), with the first three spines of the dorsal fin produced into streamers, is the Hog-fish of the West Indies. *Epibulus* (680) and *Gomphosus* (691) are remarkable for their long snout, with terminal mouth.

Parrot-
fish.

The Scaridæ or Parrot-fishes (693-701, and fig. 77) are allied to the Wrasses, but have the teeth of the jaws so coalesced as to form beaks (see skeleton of *Pseudoscarus*, 1028, Table-case 32). These beaks are extremely hard and are used by the fish to bite off pieces of coral, which together with molluscs and sea-weed make up the sum of their food. The right and left lower

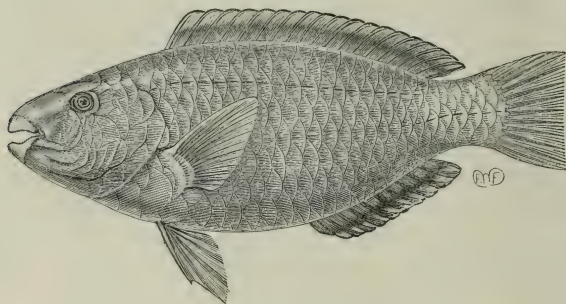


FIG. 77.—Parrot-fish, *Pseudoscarus troschelli*.

pharyngeal bones are completely fused and are armed with flat-topped teeth which bite against similar teeth borne by the upper pharyngeal bones, and are used to grind up the pieces of coral and the shells of the molluscs.

The Parrot-fishes are brilliantly, some gaudily, coloured, and the largest species grow to three or four feet. Some are valued as food, others are reputed to be poisonous. *Scarus cretensis* (694), a Mediterranean form, was much esteemed as food by the ancients. It feeds almost entirely on sea-weed, but sometimes on molluscs; if the fish has been feeding on the mollusc known as the Sea-hare

(*Aplysia*) it causes violent diarrhœa when eaten. *Odax* (700) is a southern genus, occurring on the coasts of Australia and New Zealand; the edges of the jaws are sharp and the individual teeth composing them cannot be distinguished. *Coridodax pullus* (701) is the Kelp-fish or Butter-fish of New Zealand; it lives on the small organisms growing on sea-weed, and is largely used as food.

Scombriformes (Mackerels).

The Scombriform fishes, including the Mackerels, Horse-mackerels, Sword-fishes and their allies, are closely connected with the Perciformes; they are carnivorous and marine and many are of wide distribution. The spinous dorsal fin, if distinct, is supported by short or feeble slender spines. The pelvic fins are thoracic in position, with not more than five soft rays in addition to the spine; rarely without the spine but with more than five jointed rays. The stalk of the tail is much constricted; the rays of the caudal fin are usually numerous and strongly forked at the base, embracing a considerable portion of the expanded hypural bones. The scales are usually very small or absent.

The first family, the Scombridæ, includes fishes like the Mackerel (704), Bonito (709), and Tunny (707), with fusiform body, not laterally compressed, with pectoral fins set rather high up the sides of the body, with a distinct lateral line, with wide gape and conical teeth. The premaxillary bones are large and not protractile. There are no free spines in the dorsal and anal fins; the soft dorsal fin, the hinder part of which is in most cases broken up into finlets, is longer than the spinous portion; the hind part of the anal fin may, like the dorsal, be in the form of separate finlets. The Scombrid fishes are abundant in all the seas of the tropical and temperate zones; they include some of the swiftest inhabitants of the sea, and not only are they extremely active, but they have great powers of endurance. Their muscles are of a redder colour than those of most fishes and more resemble those of warm-blooded animals. They spawn in the open sea.

Most are pelagic, a few occur in the depths of the sea ; many, such as the Mackerel and Tunny, are valued as food.

Mackerel. In the Mackerel, *Scomber scombrus*, 704, the fins are small, and the tail is deeply forked. The colours are beautiful and the general design is a dark green-blue on the back, with about 30 irregular black bands across the back and down the sides, and with a delightful play of pink and pale green on the belly according to the position in which the fish is held. This sheen is observable in the dried skin and is due to an interference of light-waves caused by minute particles of guanin or some other substance of a uric acid nature in the skin.

The Mackerel ranges from the south of Norway to the Canary Isles, and throughout the Mediterranean, also along the Atlantic coasts of the United States of America. Like the Anchovy it invades the North Sea during the summer months and retires before the winter. The shoals of Mackerel follow the Clupeoid fishes in their migrations ; on the British coasts they usually leave the open sea and approach the land in their pursuit of the young Pilchards and Sprats. The Mackerel is generally taken near the surface in drift nets and occasionally near the bottom in trawls ; the most productive British fisheries are off the south-west coasts of England and Ireland.

The Spanish Mackerel, *Scomber colias*, 706, is essentially a fish of the Mediterranean and adjacent Atlantic, but occasional stragglers are caught as far north as the Channel Isles and the English coast. It is sometimes called the Spotted Mackerel because of the distinctive blotches or spots ; it has an air-bladder, which is wanting in the common Mackerel.

In the genus *Thunnus* the anal and the second dorsal fins have each from 7 to 10 finlets, and the front, undivided portions are deep and short-based ; the stalk of the tail has a distinct lateral keel supported by a bony ridge of the vertebral centra ; the pelvic fins are small, the pectorals are more or less elongate ; the scales of the pectoral region are crowded and form what is called the 'corselet.' The Tunny (*Thunnus thynnus*, fig. 4, p. 14) is one of the largest Teleostean fishes, and grows to 10 feet and a weight of 1,000 lbs. It is abundant in the Mediterranean and ranges to

the south coast of England and southwards to Tasmania. The specimen exhibited in Table-case 38 was caught at Weymouth, and is 8 feet 4 inches long. The Tunny fishery is a regular industry in the Mediterranean and has been so since the time of the ancient Romans, to whom the salted flesh of the Tunny was known as "*Saltamentum sardicum*." *Thunnus pelamys*, the Bonito, 709, ranges over all the tropical and temperate seas and is well known to sailors, to whom it affords good sport. It rarely exceeds three feet in length. The Bonito pursues the Flying-fish, indeed, the sudden appearance of a crowd of Flying-fish above the surface of the sea generally points to the presence of a Bonito or some similar Scombroid fish. 'Albacore' is a sailors' name for any species of *Thunnus* with long pectoral fins; it probably includes other species than *Thunnus alalunga* (1021, Table-case 38) and *Thunnus albacora*. The Bonito and Albacore are preyed upon by the Sword-fish, which is their chief enemy, and also by Sharks.

Bonito.

Albacore.

In *Cybiium* (711), as in *Thunnus*, there is a firm keel at the side of the stalk of the tail, but the teeth of the jaws are large and strong; they are laterally compressed and are disposed in a single series. The scales are more reduced than in most Scombroid fishes. The species of *Cybiium* occur in the tropical parts of the Atlantic and Indian Oceans, frequenting the coast region rather than the open sea; they grow to four or five feet in length.

Elecate (712) stands rather apart from the Scombridæ in having no detached finlets in the hinder part of the dorsal and anal fins. It is placed in a family by itself, the Rhachicentridæ, *Rhachicentrum* being an earlier name than the more familiar *Elecate*. The spinous dorsal fin is reduced to about eight small spines, which are free and unconnected by fin-membrane; the pectoral fins are not set high up the sides of the body, the head is depressed, and there is no keel on the side of the tail.

Wall-case 16 is occupied by the family Carangidæ, fishes allied to the Mackerels (Scombridæ, Wall-case 15), but not having separated finlets in the hinder parts of the dorsal and anal fins.

Wall-case 16.

The dorsal spines are few; the anal fin usually has one or two spines detached from the rest of the fin. The scales are either

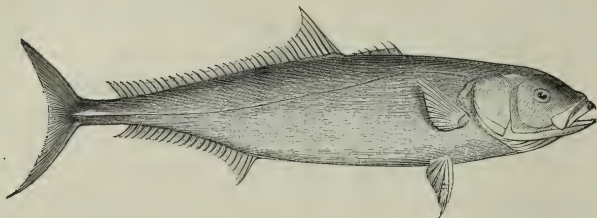


FIG. 78.—Yellow-tail, *Seriola lalandii*.

small or absent; frequently there are enlarged scutes on the sides of the body and tail; the premaxillary bones are more or less protractile. The Carangid fishes have a wide range, and are found in tropical and temperate seas. The principal genera are *Caranx* (Horse-Mackerels), *Seriola* (Yellow-tails, fig. 78), *Naucrates* (Pilot-fish, fig. 79), *Trachynotus* and *Chorinemus*. The

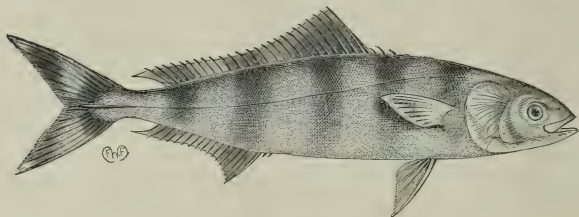


FIG. 79.—Pilot-fish, *Naucrates ductor*.

genus *Caranx* is represented in British seas by the Scad, *Caranx trachurus*, 719, the young of which live in small parties in the neighbourhood of jelly-fish, and seek shelter beneath them when disturbed. Other species shown are *Caranx affinis*, *C. ciliaris*, and *C. speciosus*, all from the Indian Ocean. The name Yellow-tail is applied to any species of *Seriola*, but more particularly to *Seriola lalandii* (721, and fig. 78) of the Southern Atlantic and Seas of Japan; *Seriola gigas* (722) and *S. dumerilii* (723) are also shown.

The Pilot-fish, *Naucrates ductor*, 725, and fig. 79, is a pelagic Pilot-fish. fish found in association with large fish, especially Sharks. It is named Pilot-fish because of its supposed habit of conducting the Shark towards suitable prey. The association with the Shark may, however, be possibly due to the fact that the *Naucrates* feeds on the parasites that infest the Shark, and also on small pieces of flesh that escape the Shark when feeding, while the well-established fact that the Pilot-fish is not attacked by the Shark may rather find its explanation in the superior agility of the former than in any sentimental reciprocity on the part of the Shark. The Pilot-fish is known to follow ships for long distances for the sake of the refuse thrown overboard, but it usually deserts the ship on nearing land. It occurs in all tropical and temperate seas and attains a length of about twelve inches. The remaining Carangid fishes exhibited are of no special interest.

At the top of Wall-case 17 the family Trichiuridæ is represented by the Hair-tail, *Trichiurus lepturus*, 739, and the Scabbard-fish, *Lepidopus caudatus*, 738, *Ruvettus pretiosus*, 741, and *Thyrsites atun*, 740. In the Trichiuridæ the premaxillary bones are not protractile as they are in the previous family, the Carangidæ; the body is elongate and laterally compressed; the spinous portion of the dorsal fin is much longer than the soft portion and the spines more or less feeble; there are no free spines to the dorsal and anal fins; the pectoral fins are set low down the sides of the body, the scales are small or absent. The fishes of this family are pelagic and widely distributed, and many occur at great depths. In the Hair-tail (739) the body is ribbon-like, and tapers to a point behind, there being no caudal fin; in the Scabbard-fish (738) the dorsal fin is not divided into spinous and soft portions, and the pelvic fins are wanting. Two other fishes belonging to this family, *Lepidopus tenuis*, 971, and *Aphanopus carbo*, 982, are shown in the case of Deep-sea Fishes, Cabinet-case 44, and a specimen of *Euxymetopon poeyi*, 1096, six and a half feet long, from Mauritius, is shown elsewhere in the Gallery.

The Sword-fishes (Xiphiidæ and Histiophoridæ) are too large to exhibit in the Wall-case among the families to which they are most nearly related, and are placed in the special case (24) that stands in the centre of the Gallery. The only specimens representing these families in the Wall-case are three vertebræ (742) from the tail region of a large Sail-fish (*Histiophorus*) showing how the caudal vertebræ interlock by means of forwardly directed laminæ of bone arising from the front of the neural and hæmal spines. A somewhat similar but less

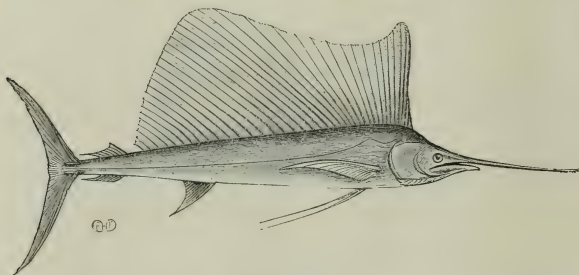


FIG. 80.—A Sword-fish, or Sail-fish, *Histiophorus gladius*.

pronounced interlocking occurs in the tail vertebræ of the Mackerel (see 705, Wall-case 15).

Sword-
fishes.
Floor-
case 24.

The Sword-fishes (Floor-case 24) are among the largest of the Teleostean fishes, and may attain a length of fifteen feet. They live in the open ocean, and are strong and rapid swimmers. The Sword-fishes of the Indian and Pacific Oceans, sometimes called Sail-fishes, belong to the genus *Histiophorus* (fig. 80), and have long, narrow pelvic fins. The Sword-fishes of the genus *Xiphias* are of world-wide distribution, and have no pelvic fins; they have transverse processes to the vertebræ and short ribs, whereas *Histiophorus* has not. In the Histiophoridæ there is, at the front of the lower jaw, a supernumerary bone known as the prementary bone; this is wanting in *Xiphias*. The "sword" or rostrum is formed by the prolongation of the

premaxillary and maxillary bones, and is an important weapon of offence. The Sword-fishes frequently attack Whales, though for what purpose is not clear, and so great is the strength of the fish when rapidly moving that the "sword" is occasionally driven into the timbers of a ship, as is shown in the specimen on the floor of the case (1081, fig. 81). In very young specimens of the Sword-fish the upper jaw is not longer than the lower. The large dorsal fin of perfect specimens is said to project above the surface of the water and to act more or less as a sail. In old specimens the dorsal fin is very greatly reduced in height, except at the anterior end. In addition to the complete specimens of *Histiophorus gladius* and *H. brevirostris* are shown a skeleton

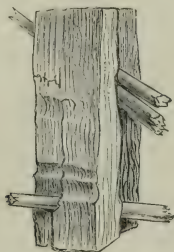


FIG. 81.—Part of the timber of a ship pierced by Sword-fishes.

and a skull of *H. brevirostris* and the rostrum of a large *Histiophorus gladius*.

Returning to the consideration of Wall-case 17, the family Bramidae is represented by Ray's Bream, *Brama raii*, 746 (a fish not related to the Common Bream, 349, Wall-case 8, nor to the Sea-bream, 602, Wall-case 14), and *Pteraclis velifer*, a fish of the Indian Ocean with remarkable enlargement of the dorsal and anal fins. The family Coryphænidæ includes the Dolphin-fishes, the commonest species of which is *Coryphæna hippuris*, 744, and fig. 82, p. 172, of wide distribution in warm seas and common in the Mediterranean. These fishes have a short, deep snout, not protractile; there are no free spines in the dorsal and anal fins, and the pectoral fins are inserted rather low down

Wall-
case 17.

Dolphin.

the sides. The Dolphins are so called from a confusion between them and the Porpoise-like animals of that name. They are pelagic in habit and pursue the Flying-fish; they are powerful swimmers and attain a length of six feet. The display of rapidly changing and flashing colours seen when the fish is taken out of the water is of short duration, and the fish when dead is dull in colour. The flesh is highly esteemed.

On the floor of Wall-case 17 is shown a remarkable, clumsy-looking fish, *Luvarus imperialis*, 743, the sole species of the family Luvaridæ. It is widely distributed over the world, but is not commonly met with; occasionally, as in the case of the specimen exhibited which was caught at Guernsey, the fish is found in British waters. The mouth is small and set low down

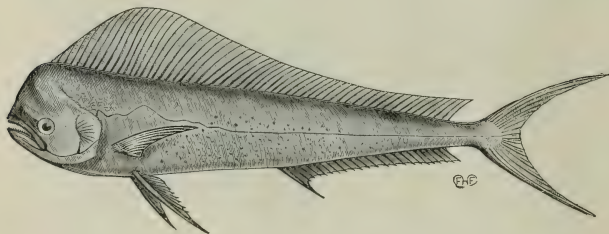


FIG. 82.—Dolphin, *Coryphæna hippurus*.

the head and has a feeble dentition; the dorsal and anal fins are supported by inarticulated, widely-set rays, and there are no free dorsal or anal spines. The pectoral fins are inserted low down, and the pelvic fins are much reduced. The surface of the body is rough, with minute scales.

Zeorhombiformes (Flat-fishes, &c.).

Wall-
case 18.

The Zeorhombiform fishes depart from the typical Perch-like fishes in having the body strongly compressed and with the precaudal region very short, the abdominal cavity being comparatively small and the anus set well forward. The fin-rays of the pelvic fin may be as many as seven or nine. The division

includes the family Zeidæ (John Dory, &c.), Amphistiidæ (extinct), and Pleuronectidæ (Plaice, Sole, &c.). In the first two families the body is symmetrical about the median plane, in the third family the one side, either the right or the left, is pale and the other side dark; the two eyes are on the dark side and the greater part of the mouth is on the pale side.

In the Zeidæ the mouth is very protractile. The dorsal and anal fins are much elongated, the former with a distinct spinous portion, the latter with from one to four spines detached from the non-spinous portion of the fin. The pelvic fins have one spine and from six to eight soft fin-rays. A swim-bladder is present. The family is a small one, and the species most important in this country is the John Dory, *Zeus faber*, 750, a fish much valued for the table. In colour the John Dory is yellowish-grey, with wavy-bands, and a large black spot edged with yellow. The English name John Dory is said to be a corruption of an old Gascon name "Jan Dorée," signifying Gilt-Cock; another derivation is from "Janitore," after St. Peter, whose finger-mark was supposed to be the cause of the dark patch on each side. In Germany the fish is called "Petersfisch," and at Nice "Peï San Pierre." The Dory feeds on Sprats and similar fishes, and it swims with the median plane of the body not quite vertical, but slightly oblique. It is essentially a warm water fish; it occurs in the Mediterranean and along the Atlantic coast from Madeira to Norway; it is common in the English and Bristol Channels, where it is taken in the trawl; in the North Sea it is rare. *Zeus conchifer*, 751, of Madeira, is a larger species than the John Dory, and differs in the number and disposition of the bony plates that occur in the skin at the bases of the fin-rays of the dorsal and anal fins.

Dory.

The Amphistiidæ are an extinct family with the single genus *Amphistium*, from the Upper Eocene. *Amphistium* is interesting as being in all probability the prototype of the Pleuronectid fishes, before the origin of the asymmetry characteristic of that family. The dorsal and anal spines are few, and in continuous series with soft fin-rays; the pelvic fins have each a spine and eight soft rays.

Flat-
fishes.

The fishes of the family Pleuronectidæ, commonly known as Flat-fishes (figs. 83 and 84), lie upon their side when resting on the bottom of the sea. The front part of the skull is twisted in such a manner that the two eyes are on the upper surface, and as may be seen by reference to the cranium of the Halibut, 755, the hinder part of the skull that contains the brain does not share in the torsion. The under surface of the fish, known as the "blind" side, is flat and white in colour, whereas the upper surface is pigmented and more convex. The dorsal and anal fins are extensive and form a kind of fringe to the flattened body. The paired fins are often reduced, sometimes absent. There is no swim-bladder. The Pleuronectidæ constitute a large family of fishes, almost all of them marine. They are valuable food-fishes and are represented in British waters by the Sole, Turbot, Brill, Plaice, Halibut, &c. In the Turbot and Brill the eyes are on the left side, in the others they are on the right side. The food of the Flat-fishes consists principally of molluscs, crustaceans and sea-worms, but the Turbot and Brill feed on fishes, such as the Launce, Herring, Whiting, and even small fishes of their own family, such as the Sole and Plaice.

Adalah.

The least specialised of the family Pleuronectidæ is the Adalah, *Psettodes erumei*, 752 and 753, fig. 83 A, of the Indian Ocean and seas of China and Australia; the pelvic bones and fins are placed as in an ordinary fish such as the Perch, and the dorsal fin does not extend on to the head. It has been pointed out above that the two eyes of the Flat-fishes are on the same side of the body, but this does not apply to the very young. The fishes commence their existence as perfectly symmetrical fishes with their eyes on opposite sides of the head and their jaws similar on the right and left sides. As development proceeds and the body becomes more and more flattened, one of the eyes moves to the edge and then over to the same side of the body as the other eye, owing to a twisting of the front part of the skull. The Adalah is interesting in that it retains more completely the bilateral symmetry of the young than do any of the other Flat-fishes. The eye which migrates—sometimes the right, sometimes the left, since both right-handed and left-handed forms occur in this species (compare 752 and 753)—remains on the edge of the head, and does not come over completely on to the pigmented

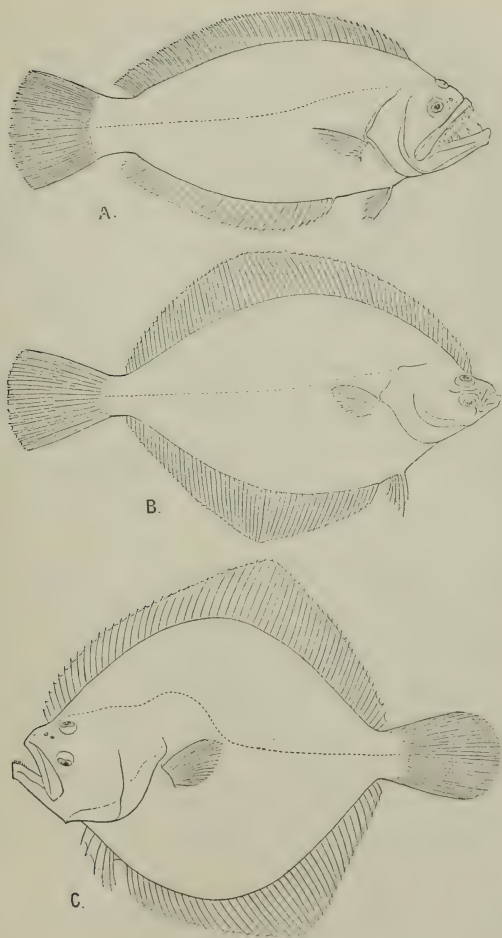


FIG. 83.—Flat-fishes.

A, Adalah, *Psettodes erumei*; B, Plaice, *Pleuronectes platessa*; C, Turbot, *Rhombus maximus*.

(After Boulenger, Camb. Nat. Hist., vii, 1904.)

side of the body. The right and left jaws of this fish are almost equally developed, and the teeth are much more powerful than in Flat-fishes generally.

Halibut. After *Psettodes*, the least specialised of the Flat-fishes is *Hippoglossus*, a genus including the Halibut, 754. In *Hippoglossus* the eyes are on the right side, the mouth is terminal and large, and teeth are present on both sides of the mouth. The body is long and comparatively narrow, and the dorsal fin commences above the more dorsally placed of the two eyes. The lateral line has a slight curve; the scales are cycloid. The Halibut inhabits the deeper waters along the southern shores of the Arctic Ocean. It occurs off Spitzbergen, Norway, Iceland, Newfoundland, Alaska, California and Kamschatka. It is taken chiefly on long lines, at depths ranging from 50 to 100 fathoms. About 150,000 cwts. of Halibut, valued at £300,000, are landed in Britain annually, mainly from the Iceland and Farøe banks. The Halibut is the largest of the Flat-fishes and commonly attains a length of six or seven feet; a specimen six feet long (1036) is shown on Table 49.

Hippoglossoides, represented by the Long Rough Dab, *Hippoglossoides limandoides*, 763, a fish of 12 or 15 inches in length, living in rather deep water in the north European seas, resembles *Hippoglossus* in that the eyes are on the right side and the mouth is terminal and large, with teeth on both sides; but the anterior end of the body is not much narrowed; the dorsal and ventral edges are rather straight; the scales are ctenoid; the lateral line is straight.

Turbot and Brill. In the genus *Rhombus* the mouth is large and terminal, with teeth on both sides, the eyes are on the left side, and the ventral eye is anterior to the dorsal. The shape of the body is rhomboidal, the middle of the body being very broad; the lateral line has a semicircular curve anteriorly. The Turbot and Brill belong to this genus, the former being known as *Rhombus maximus* (756 and 757, fig. 83 C, and the latter as *Rhombus levis* (759 and 760). The Turbot differs from the Brill in having no ordinary scales but pointed tubercles scattered in the skin (compare the tubercles 758 and the scales 761). It is broader than the Brill in proportion to its length. The Turbot ranges from the Mediterranean to the southern part of Scotland and

the Skagerak. It is a shallow water fish, being rarely taken in depths exceeding 40 fathoms. About 70,000 cwts. of Turbot, valued at £300,000, are annually landed in Britain, mostly from the North Sea trawling grounds. The Brill has the same general distribution as the Turbot.

Pseudorhombus russelli, 764, is a fish widely distributed over the Indian Ocean and seas of East Africa, China and Australia. Closely allied to it is *Paralichthys dentatus*, 765 and 766, the "Flounder" of the Atlantic coast of America. In this fish the middle fin-rays of the caudal fin are longer than the others, so that the hind edge of the tail is not rounded, but has the form of an obtuse angle.

The genus *Pleuronectes* is represented by the Plaice, the Flounder and the Dab. In this genus the mouth is terminal and very small, the teeth are more developed on the lower side than on the upper; the eyes are large and prominent, the dorsal fin commences above the dorsal eye; the scales are small and in some cases rudimentary. The Plaice, *Pleuronectes platessa*, 767–771, fig. 83 B, has uniform scales, some bright red or orange spots, a lateral line nearly straight, bony tubercles on the inter-orbital ridge, and a spine in front of the anal fin. The Plaice is comparatively a cold water fish. It is abundant all round the British and Irish coasts, on the coast of Iceland, and in the White Sea. It is very rare in the Mediterranean. It is taken only by the trawl, and in depths usually less than 30 or 35 fathoms. About 1,100,000 cwts. of Plaice, of the value of £1,200,000, are landed in Britain annually. Nine-tenths of the total are taken in the North Sea, where the young Plaice are mostly reared along the shallow coasts of Holland, Germany, and Denmark, from which they migrate off-shore as they grow older. The more northern forms, e. g. those taken off Iceland, are very dark in colour.

Plaice.

The Flounder, *Pleuronectes flesus*, 774 and 775, has tubercles at the bases of the fin-rays of the dorsal and anal fin; the scales are rough along the lateral line, elsewhere they are rudimentary; yellow spots are only exceptionally present. The Flounder is an estuarine fish except in the spawning season, when it descends

Flounder.

to the sea. It occurs on all the coasts of Europe from the Mediterranean to the most northern waters of the Baltic. In the Zuyder Zee and Baltic the Flounder fisheries are valuable, but in Britain the annual take is only about 35,000 cwts. valued at £18,000. The Flounder grows to about 3 lbs. in weight. The Dab, *Pleuronectes limanda*, 773, is a small fish of little commercial value.

Glyptocephalus, a genus related to *Pleuronectes*, is represented in British seas by two species, the Witch, *Glyptocephalus cynoglossus*, 777, and the Smear Dab, *Glyptocephalus microcephalus*, 776. This last is often sold in the London markets as "Lemon Sole," the small head and rounded outline of the body giving the fish some resemblance to the true Sole. An easy test may be applied by examining the scales with a lens, for the scales of "Lemon Sole" are cycloid, with smooth hind edge, whereas those of the Sole are ctenoid, with the exposed part rough and bristly or toothed.

The Scald-fish, *Arnoglossus laterna*, 778, is a small and unimportant fish with a skin which is thin and tears off so readily as to suggest that the fish has been scalded. Two species of Topknot occur in British seas, the One-spotted Topknot, *Zeugopterus unimaculatus*, 779, and Miller's Topknot, *Zeugopterus punctatus*, 780; the One-spotted Topknot is a more southern form than the other and is found as far south as the Mediterranean, whereas Miller's Topknot does not occur farther south than the Bay of Biscay.

The Megrin or Whiff, *Lepidorhombus megastoma*, 781, is a fish growing to about 18 inches in length, and occurring off the coasts of Britain and Scandinavia. *Ammotretis rostratus*, 782, and *Rhombosolea fiesoides*, 783, are Australian forms of Flat-fish.

Sole. In the genus *Solea* the mouth is rather small and not terminal; it is curved downward towards the ventral edge. Teeth are present on the lower side only. The shape of the body is oval, the outline of the snout semicircular; the dorsal fin commences on the snout and is not continuous with the caudal; the lateral line is straight, but with an anterior dorsal curve on the head; the dorsal eye is anterior to the ventral. There are tactile filaments

on the lower side of the snout; the scales are ctenoid. Four species of *Solea* occur off our coasts, the Common Sole, the most valuable of the four, the Sand Sole, the Thickback and the diminutive Solenette.

In the Common Sole, *Solea vulgaris*, 784, fig. 84 D, the pectoral fins of both upper and under sides are of considerable size, and the nostrils of the two sides are similar. The markings of the upper side consist of longitudinal series of black blotches on a yellowish-brown ground. The Sole is the most valuable of the Flat-fishes on account of the delicacy of its flavour. It is a warm water fish, and is abundant in various localities around the coasts of England and Ireland, less common on the coast of

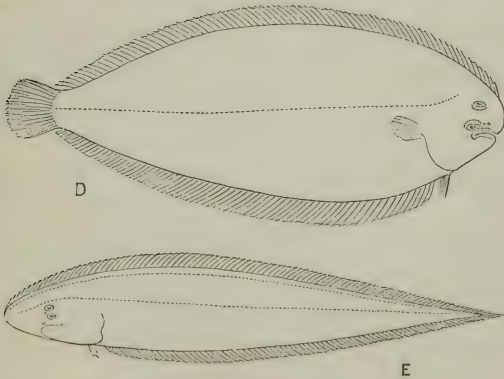


FIG. 84.—Flat-fishes (*continued*).

D, Sole, *Solea vulgaris*; E, *Cynoglossus lingua*.

(After Boulenger, Camb. Nat. Hist., vii, 1904.)

Scotland; it occurs also plentifully in the Bay of Biscay, off Portugal and in the Mediterranean Sea. The Sole is caught exclusively by the trawl, and in depths of less than 25 fathoms. Between 75,000 and 80,000 cwts. of Soles, valued at about £500,000, are landed in Britain annually. The principal British fishing grounds are off the Devon and Cornish coasts, and off

Ramsgate, Lowestoft, and Grimsby, but many of the Soles that come to the London market are caught off Portugal and Morocco.

Sand Sole. The Sand Sole, *Solea lascaris*, 786, differs from the Common Sole in being paler in colour after death, in having small black specks instead of large black blotches, and in the anterior nostril of the lower side being large and conspicuous and fringed internally. There is a black spot with a yellow margin on the pectoral fin. The Sand Sole is sometimes called the Lemon Sole, but the fish that is sold in London as the Lemon Sole is the Smear Dab, *Glyptocephalus microcephalus*, 776. The Thick-back, *Solea variegata*, 787, is smaller than the Common Sole, and the mouth is straight and more terminal. The colour-markings consist of five dark bands on a reddish-brown ground; the pectoral and pelvic fins are rudimentary. The Solenette *Solea lutea*, 788, is distinguished by the mouth being much curved and by the dorsal fin commencing on the extreme anterior end of the snout. There are dark blotches on a yellowish ground, and the dorsal and anal fins have a few scattered black fin-rays. The Solenette does not exceed five inches in length.

The genera *Synaptura* (789 and 790) and *Cynoglossus* (791, fig. 84 E) differ from *Solea* in the dorsal and anal fins being confluent with the caudal fin. In *Synaptura* the eyes are on the right side, the upper in advance of the lower; in *Cynoglossus* the eyes are on the left side, there are no pectoral fins, and the upper part of the snout is produced backwards into a hook. The fishes of these genera occur in the tropical seas of the Old World.

Gobiiformes (Gobies).

The division Gobiiformes is a small division of the suborder Acanthopterygii and includes a single family, the Gobiidæ; the species of the family are numerous, and the fishes are mostly marine and of small size, although some species of *Eleotris* grow to two or three feet in length. The pelvic fins are thoracic in position and consist of one feeble spine and four or five branched rays; they are in many species united to form a sucking disc.

The Gobies proper (genus *Gobius*) are common in shallow coastal waters around the British Isles and the Continent of Europe, the British forms including the Common Goby, *Gobius minutus*, 801, the Rock Goby, *Gobius paganellus*, 796, the Painted Goby, *Gobius pictus*, 802, the Spotted Goby, *Gobius ruthensparri*, 800, and fig. 85. and the Black Goby, *Gobius niger*, 799. The last species is mostly of an ashen grey colour, but when excited, as when in pursuit of its prey or when caught in a net, it changes to a dark smoke-colour. The Gobies are interesting on account of their breeding habits. The eggs are fixed by the female to the under surface of stones or weeds (see 1147, in Cabinet-case 29), or beneath a simple nest made out of shells of the Cockle or Limpet, or a Crab-shell. The

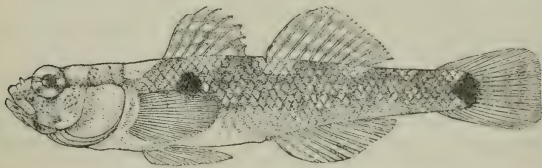


FIG. 85.—Spotted Goby, *Gobius ruthensparri*.

(From Boulenger, Cam. Nat. Hist., vii, 1904, after Holt and Byrne).

male is more brilliantly coloured than the female, and guards the eggs until they are hatched, remaining attached to the stone or shell by its pelvic sucker. The White Goby, *Aphia pellucida*, 803, has a transparent and colourless body, and was formerly supposed to be the fry of a larger fish. It does not live more than a single year. The Walking-fish or Jumping-fish, *Periophthalmus koelreuteri*, 804, is common on the mud-flats at the mouths of rivers in tropical Africa, Asia and Australia. It jumps about by the exercise of its stout pectoral fins and appears a curious object with its head raised and its two bulging eyes set close together near the top of the head.

Echeneiformes (Sucking-fishes).

The Echeneiformes constitute a small division of the Acanthopterygian fishes, containing a single family, the Echeneidæ, and characterised by the anterior dorsal fin being set well forward upon the top of the flattened head, and modified into a sucker by the right and left halves of the fin-rays being bent outwards so as to form a paired row of transversely placed lamellæ with rough edges. The margin of the sucking disc is soft and membranous (see isolated sucker, 808). The mouth is terminal, and the mandible advanced; the second dorsal and the anal fins are long in the base, without spines, and opposed to each other; the pectoral fins are inserted high up the body, the pelvic fins are thoracic in position and have each one spine and five soft fin-rays. The Echeneidæ were formerly regarded as allied to such Scombriform fishes as *Elecate* (712, Wall-case 15), but are now considered to occupy an isolated position.

Remora. The Remora or Sucking-fish, *Echeneis remora*, 807, and fig. 86, is found in all tropical and warm seas, and is sometimes caught as far

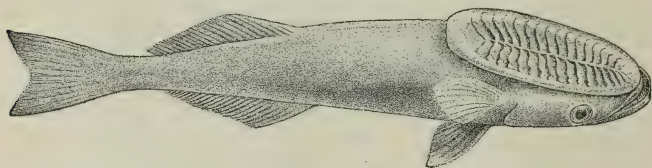


FIG. 86.—Remora or Sucking-fish, *Echeneis remora*.

north as the south coast of England. It attaches itself by means of its adhesive disc to Sharks, Whales, Turtles, and even to boats, and is thus carried from place to place. It is not a parasite and does no harm to the large animal to which it is attached. When thrown on the deck of a ship a Remora will lie on its back and cling so closely to the wood by its head sucker that it can only be dislodged by a forward sliding motion. The Remora feeds on small fishes and probably also on the skin parasites that infest large fishes and Whales.

Echeneis naucrates, 806, is closely allied to the Remora, but is more slender and has a relatively longer tail, and more fin-rays in the anal fin. In the Torres Strait the natives employ the *Echeneis naucrates*, or Gapu, as they call it, for catching Turtles. The fish is kept alive in water in the bottom of the canoe a thin string being fastened round its tail and through its gills. On a turtle being sighted in the vicinity of the canoe the Gapu is thrown out towards it; the fish immediately swims to and fastens upon the carapace. If the turtle is of small size it is hauled in by the line, the fish retaining its tenacious hold, but if it be a large one a native jumps overboard with a stronger line, and following the course of the fine line arrives at the turtle and securely ties it by the stronger rope, returns to the canoe and tows his captive to land.

Triglifformes (Gurnards).

The fishes of the division Triglifformes have an "armoured cheek"; the second suborbital bone is produced towards or fused with the pre-opercular bone and forms what is known as a "sub-orbital stay." The pelvic fins are thoracic in position. The division includes comparatively simple Perch-like forms such as *Sebastes* and aberrant forms such as the Gurnards, with fully armoured head, the Flying Gurnards, with enlarged pectoral fins, and the Lump-suckers, with pelvic fins forming a sucking disc.

In the family Scorpenidæ the head is usually provided with spines, but is not completely cuirassed. The spinous dorsal fin is strongly developed and is usually longer than the soft dorsal fin; the anal fin usually has three spines. The fishes included in this family are carnivorous and marine and of wide distribution. Species of *Sebastes* and of allied genera are used as food. The dorsal fins of some, such as *Scorpena*, *Pterois*, *Synanceia*, are provided with poison glands, and can inflict dangerous wounds.

Scorpenidæ.

The Bergylt, *Sebastes norvegicus*, 812, called by some fish-mongers the 'Soldier' on account of its bright red colour, is a fish confined to northern seas, such as those of Norway and Iceland;

Bergylt.

it is esteemed as food, and occasionally finds its way to the London markets. *Scorpæna* is a widely distributed genus, the species *Scorpæna scrofa*, 816, being common in the Mediterranean; *Scorpæna cirrhosa*, 814, and *Scorpæna diabolus*, 815, are tropical forms. *Pterois miles*, 817, is an Indian fish remarkable for its brilliant red colour and the elongation of most of its fin-rays. Species of *Agriopus* (818–820), *Synanceia* (821–822), *Pelor* (824) and *Centropogon* (823) are also shown.

Wall-
case 19.

The division Triglifformes continues from Wall-case 18 into Wall-case 19, the first family in the latter being the Hexagrammatidæ, comprising carnivorous fishes, mostly of large size, although the specimen exhibited, *Chirus hexagrammus*, 827, is of moderate size only. They occur on the rocky coasts of the North Pacific, and some of them are valued as food-fishes. The head has no strong spines and is not cuirassed, and there is a single nostril on each side, whereas in the preceding family (Scorpenidæ) there are two. The spinous dorsal fin has feeble rays.

Bull-
heads.

The fishes of the family Cottidæ have two nostrils on each side and the head is usually provided with spines. The spinous dorsal fin is usually shorter than the soft dorsal and sometimes indistinct; the anal fin is without spines. The majority of the Cottid fishes are marine and found in northern seas. The best known forms of *Cottus* are the Miller's Thumb, *Cottus gobio*, 831, a little fresh-water fish growing to five inches in length, very bulky about the head and gills, with eyes set on the top of the head, and with pectoral fins large and spreading out like fans, and the marine Bull-heads, e.g. the Father-lasher, *Cottus bubalis*, 830, and the Sea-scorpion or Sting-fish, *Cottus scorpius*. *Cottus grælandicus*, 828, is probably but a northern form of *Cottus scorpius*. In America the species of *Cottus* are called "Sculpins," but in Britain the name Sculpin is applied to the Dragonet, *Callionymus lyra*, 865.

Lump-
sucker.

The Cyclopteridæ are distinguished from the Cottidæ by the small size of the gill-opening and by the pelvic fins being modified to form a sucking disc (835). The body is short and tumid,

and the spinous dorsal fin, if present, is short. The fishes are sluggish in habits, and of wide distribution. The best known forms in British seas are the Lump-sucker and the Sea-snail. The Lump-sucker, *Cyclopterus lumpus*, 833-834, and fig. 87, is a

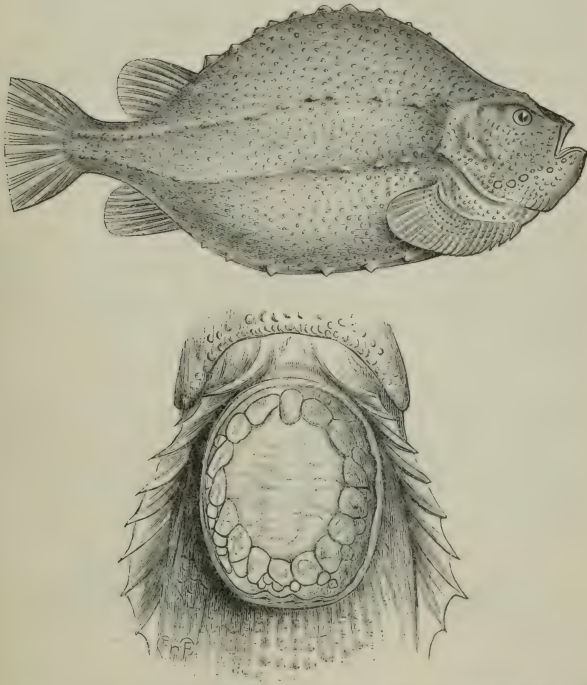


FIG. 87.—Lump-sucker, *Cyclopterus lumpus*; with a separate view of the sucking-disc.

clumsy-looking fish with a thick tuberculated skin and thin transparent bones. At the breeding season the male is more brilliantly coloured than the female. The eggs are laid in a pit made by the

male, who watches over them until they hatch. The young then cling to his body by their suckers and remain thus attached until sufficiently grown to take care of themselves. The Sea-snails are diminutive fishes, two species of which are common on the coasts of Cornwall and Devon, *Liparis vulgaris*, 836, and *Liparis montagui*, 837. A deep-sea form of Sea-snail, *Paraliparis fimbriatus*, 973, is shown in the series of Deep-sea Fishes in Cabinet-case 44.

In the families Platycephalidæ and Hoplichthyidæ the head is depressed, with spines, and with two nostrils on each side. The pelvic fins are widely separated and are set behind the pectorals in the former family and a little in advance of them in the latter. The fishes occur off the coasts in the Indian and Western Pacific Oceans (see 838–839).

The Agonidæ have the head completely cuirassed; the body is covered with bony plates. The pelvic fins are set close together and none of the fin-rays of the pectoral fin are modified as “feelers” as they are in the next family, the Triglidæ or Gurnards. The

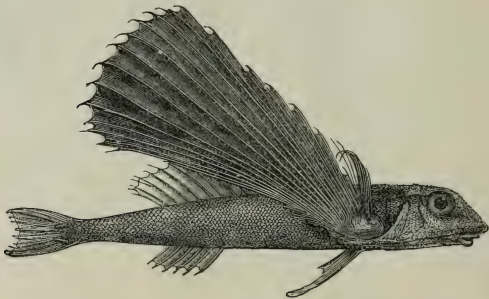


FIG. 88.—Flying Gurnard, *Dactylopterus volitans*.
(From Günther, “Study of Fishes.”)

fishes are small; the only British form is the Pogge, *Agonus cataphractus*, 840.

Gurnards. In the Triglid fishes or Gurnards the head is completely cuirassed and provided with spines. Two or three of the lower-

most pectoral fin-rays are modified as delicate "feelers" which the animal uses as it moves about close on the sea-bottom in search of the small crustaceans that constitute its food. The pelvic fins are widely separated. The Gurnards are marine and are widely distributed in warm and temperate seas. The species found in British waters include the Grey Gurnard, *Trigla gurnardus*, 848; the Red Gurnard, *Trigla pini*, 845; the Cuckoo Gurnard, *Trigla cuculus*, 847, and the large Tub-fish or Sapphirine Gurnard, *Trigla hirundo*, 843. The Cape Gurnard, *Trigla capensis*, 849, does not differ materially from our Red Gurnard. Two species of the Armed Gurnard, *Peristedion* (841 and 842), and a specimen of the Australian *Lepidotrigla* (850) are also shown.

In the Flying Gurnards or Dactylopteridæ, fig. 88, the head is completely cuirassed, and the body is covered with hard, rough scales. The pelvic fins are set close together; the pectoral fins are divided into two portions, the second of which is very large in the adult. The Flying Gurnards inhabit tropical and warm seas, and are able to move through the air like the Flying Fish (*Exocoetus*, 452, Wall-case 11), though for shorter distances. The fish emerges from the water with considerable impetus, and the rapid agitation of the large pectoral fins enables it to traverse a distance of several feet before falling back into the water. The best known Flying Gurnard is the *Dactylopterus volitans* (851 and 852, skeleton), of the Mediterranean Sea and the temperate and tropical parts of the Atlantic Ocean. A specimen of an oriental species is also shown (853).

Blenniiformes (Blennies).

The division Blenniiformes or Jugulares includes a number of families of Acanthopterygian fishes in which the pelvic fins are set forward under the throat. There is no bony stay to the preoperculum; the gill-opening is in front of the pectoral fin, the base of which is vertically disposed or nearly so. The division includes such fishes as the Weevers, Star-gazers, Dragonets, Blennies, Wolf-fishes and Toad-fishes.

Weevers.

In the first family, the Trachinidæ, are included the Weevers (fig. 89), small fishes with a large, protractile mouth, an elongate body with cycloid scales in oblique bands, a short spinous dorsal fin, and a long soft dorsal and anal. The Weevers are found off the coasts of Europe and West Africa. There are two British species, which can inflict painful wounds by means of the dorsal and opercular spines, which are connected with poison glands and are channelled for the passage of the venom. The Greater Weever,

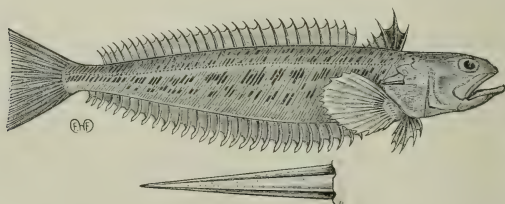


FIG. 89.—Weever, *Trachinus draco*, with an enlarged view of the poison spine.

Trachinus draco, 854, is a marketable fish in France; the flesh is of excellent flavour, but our fishermen usually prefer to throw the fish away than to run the risk of being pricked by the poison-spines when handling the fishes in sorting them out from the others in the boat or on the quay. The name 'Weever' is probably a corruption of the Anglo-Saxon "wivere," a viper or serpent, and has reference to the poison-spines. The Viperine Weever, *Trachinus vipera*, 855, is smaller than *Trachinus draco*, and lives in shallower parts of the coast; it differs also in having a fringe on the lips and in having no scales on the cheeks and gill-covers.

The Nototheniidæ are closely allied to the Weevers, but differ in the pelvic fins being widely separated. There is a single nostril on each side, and the scales are usually ctenoid, sometimes absent. The Nototheniid fishes occur mostly in southern seas. Three species of *Percis* are shown (857–859), and one of *Chænichthys* (856).

The Star-gazers (family *Uranoscopidæ*) are a natural and well-defined family deriving their name from the eyes being set on the upper surface of the large, broad head and looking upward as though gazing at the stars. The mouth slit is nearly vertical, the lower jaw being pushed well forward; granular ossifications are developed on the roof and sides of the head. These fishes are inhabitants of most warm and tropical seas. The common Star-gazer of the Mediterranean, *Uranoscopus scaber*, 861, was well-known to the ancient Greeks, who termed it the 'Agnos,' or Holy-fish; they also knew it as the 'Ouranoscopus,' or Heavenward-looking Fish.

Star-
gazers.

The Star-gazer is a poor swimmer and lives mostly in the mud and sand. A newly caught specimen put into an aquarium sinks to the bottom of the water and by a few vigorous shovelling movements of the pectoral fins buries itself in the sand until only the mouth and eyes project. Here it lies quietly, the only signs of its existence being a slight rhythmical disturbance of the sand as the expired water leaves the gill-chamber, an occasional jerk of the eyes, and the waving of a delicate filament which is attached to the floor of the mouth and projects through the mouth opening. This is evidently the bait with which the Star-gazer angles. When a small fish, mistaking this filament for a harmless worm wriggling in the sand, approaches within reach of the jaws, there is a sudden disturbance of the sand caused by the rapid opening of the Star-gazer's mouth, and the career of the small fish is ended.

In addition to the Common Star-gazer (861) are shown two species occurring in the seas of China and Japan (860 and 862) and specimens of the Australian forms *Kathetostoma* (864) and *Anema* (863).

The *Callionymidæ* include the Dragonets, fishes with a rather small and protractile mouth, a narrow gill opening, and a scaleless skin. The first dorsal fin is composed of a few flexible spines; the second dorsal and the anal fin are rather short. The fishes are small and widely distributed. The Common Dragonet of our shores is *Callionymus lyra*, sometimes called the Sculpin (866,

Drago-
nets.

female; 865, male). At the breeding season the male becomes brilliantly coloured and differs from the female in the shape of the snout and the dorsal fins.

The fishes of the family Gobiesocidæ have a protractile mouth of moderate size; the pelvic fins are widely separated from each other; the dorsal and anal fins are short and without spines; there are no scales in the skin. There is a ventral sucker, simple or double, supported by the pectoral and pelvic girdles and the pelvic fins. These fishes, known as Cling-fishes, are small, and are met with between tide-marks among loose stones and shells, to which they cling by their ventral sucker. They are of world-wide distribution; species of *Lepadogaster* occur on the British coasts, particularly the Cornish Sucker, *Lepadogaster gouanii*, 868.

Wolf-fish.

The Blenniidæ have more or less elongate bodies, naked or with small scales. The dorsal and anal fins are long, and the caudal is distinct. All of the dorsal fin-rays are spinous or non-articulated, or the anterior ones only. The family is a large one, composed mostly of small marine fishes; the largest are the Wolf-fishes (*Anarrhichas*), some of which grow to five feet in length. The Common Wolf-fish is *Anarrhichas lupus*, 871, and fig. 90, in some

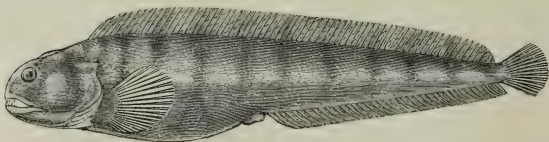


FIG. 90.—Wolf-fish, *Anarrhichas lupus*.

parts known as the Cat-fish or Sea-cat. The Wolf-fishes are unprepossessing, voracious animals with powerful body and strong jaws and teeth (see skull 872). The Wolf-fish has been known to attack persons wading in the water at low tide. The flesh is good, but is not much eaten. The genus *Blennius* is represented in the exhibited series by the Tompot, *Blennius gattorugine*, 873, and the Shanny, *Blennius pholis*, 874, both of which occur in British

seas. The other forms shown, *Gadopsis*, *Clinus*, *Tripterygium* and the curious looking *Pataecus*, are from the Australian region.

The fish known as the Viviparous Blenny (881-882), one of the few bony fishes that bring forth their young in an actively living state instead of depositing eggs or spawn, belongs to the family Zoarcidæ. The Zoarcidæ have very small scales or no scales in the skin; the dorsal and anal fins are long in the base and there is no distinct caudal fin; spinous fin-rays as a rule are wanting. The family is widely distributed in all seas, and some of the forms are adapted for life at great depths and have reduced eyes, to be seen only on dissection. The Cuban Cave-fish, *Lucifuga subterranea*, 880, is the only fresh-water form, and this also is blind. It is colourless and transparent, and grows to a length of five inches.

The Gunnel or Butter-fish, *Pholis gunnellus*, 879, belonging to the family Pholididæ, is a little fish common on our shores, and remarkable for the manner in which the female rolls the eggs into a ball and deposits them in a hole in the rock bored by the bivalve mollusc *Pholas*.

The Batrachidæ or Toad-fishes are a small family of fishes with a broad, flattish head and reduced gill openings. The mouth is large and the upper border is supported to a considerable extent by the maxillary bones. The spinous dorsal fin is very short, the soft dorsal, and the anal fin long in the base. The fishes of the family are sluggish and voracious, and occur near the shores of tropical and warm seas. The European Toad-fish, *Batrachus didactylus*, 878, has scales, but the American Toad-fish is without scales. The young of the former has on the ventral surface of the body a sucking disc, which soon disappears.

The Ophidiidæ are fishes related to the Zoarcidæ; they have a tapering tail without a distinct caudal fin, and the pelvic fins are reduced to two pairs of filaments set just behind the chin. There are no spines to any of the fins. The example shown is *Genypterus blacodes*, 883, from Australian seas. *Aphyonus gelatinosus*, an example of one of the deep-sea members of the family, is exhibited in the series of Deep-sea Fishes (Cabinet-case 44, specimen 974).

Trachypteriformes (Ribbon-fishes).

Ribbon-
fishes.

The division *Trachypteriformes* is a small one, containing the two families *Lophotidæ* and *Trachypteridæ*, the former with a single genus, *Lophotes*, the latter with two, *Trachypterus* and *Regalecus* (fig. 91). The body is much laterally compressed, usually ribbon-like in shape, whence the popular name "Ribbon-

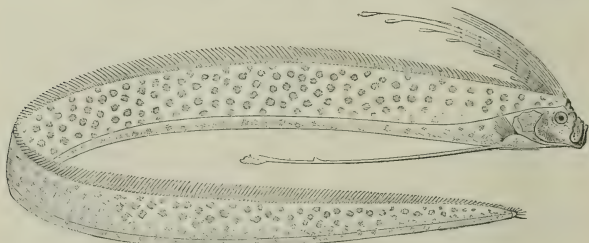


FIG. 91.—Ribbon-fish, *Regalecus gladius*.

fishes." The dorsal fin extends from the top of the head to the tail, its rays are simple and not spinous, and the anterior rays are longer than the others. The pectoral fin has a nearly horizontal base; the scales are minute or absent. These fishes occur in the deeper parts of the Atlantic, North Sea, Mediterranean, and Pacific. In the family *Lophotidæ* the vent is situated far back, and behind it is a short anal fin, but in the *Trachypteridæ* there is no anal fin and the vent is situated at about the middle of the length of the body. The mouth is very protractile in the *Trachypteridæ*, moderately so in the *Lophotidæ*.

The Deal-fish or Northern Ribbon-fish, *Trachypterus arcticus*, of which a coloured drawing (885) of the natural size is shown, has six fin-rays in the pelvic fin, and the caudal fin consists of two parts, the upper of which is large and upwardly directed. Specimens of the Deal-fish are occasionally stranded upon the coasts of Scotland and Norway. In the young *Trachypterus* (886) the fin-rays of the first dorsal and the pelvic fins are remarkably long, and the dorsal fin-rays are provided with arrow-head lappets of skin set at regular intervals. A specimen of *Trachypterus cristatus* from the Mediterranean is shown, mounted in a glass vessel of alcohol (884).

Regalecus has no caudal fin, and the pelvic fin is composed of a single fin-ray. The Oar-fish or Ribbon-fish (*Regalecus glesne*) is occasionally cast up on the coasts of Cornwall and Yorkshire, and off Bergen, in Norway. The Scandinavian fishermen call it the "Sild-Kung" or King of the Herrings, and imagine that if one is killed the Herrings will depart from the district. The coloured drawing 887 is a life size representation of the Southern Ribbon-fish, *Regalecus argenteus*, specimens of which are obtained off New Zealand and Australia. A skeleton of *Regalecus argenteus* twelve feet long is shown elsewhere in the Gallery. Some of the "Sea-serpents" seen by sailors and others may have been large specimens of the Ribbon-fish. Specimens of more than 25 feet in length are known.

LOPHIIFORMES (Angler-fishes).

The Lophiiformes, known also as the Pediculati, are a suborder of Teleostean fishes comprising the families Lophiidæ (Angler-fishes), Ceratiidæ, Antennariidæ, and Malthidæ (Bat-fishes). The pectoral fins are set far back and the bones of the fins are elongated; the pelvic fins are jugular in position. The head is large, the gill-opening is small and far back, and the gills are reduced in number to two or three on each side. One or more dorsal fin-rays standing upon the head are modified into tentacular structures known as "lures." The Lophiiform fishes are poor swimmers and are mostly of sluggish habits.

Wall-case 20.

In the Lophiidæ (fig. 92) the mouth is very large and has teeth which are so hinged as to bend over towards the throat (see jaw 893). The skin is soft and bare. The fishes have a depressed body and live on the bottom, at moderate or great depths. The most familiar is the Angler-fish, Fishing-frog or Sea-devil, *Lophius piscatorius*, 892, in which the first few dorsal fin-rays are set over the snout and are long and flexible; they terminate in dermal expansions which are the lures. The fish "angles" with these lures, and by a sudden opening of its great mouth swallows such small fishes as nibble at them. Around the margin of the body are fringed lappets of skin which by their resemblance to sea-weed

Angler.

serve to render the body less conspicuous (fig. 92). The Angler grows to five feet in length; two specimens of about that length, and also a large skeleton, are shown elsewhere in the Gallery.

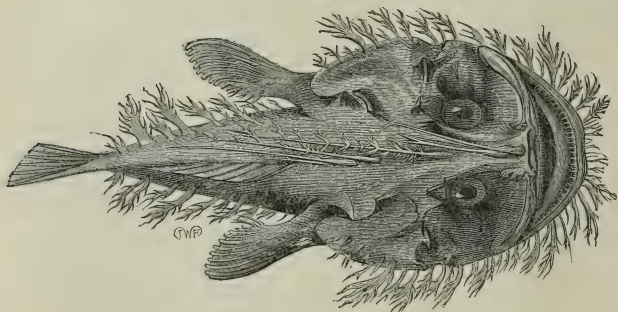


FIG. 92.—Angler or Sea-devil, *Lophius naresii*. The branched processes of skin are longer in this than in the British species, *Lophius piscatorius*.

The Ceratiidæ, represented by *Dolopichthys allector* in the series of Deep-sea Fishes (Cabinet-case 44, specimen 972), may be regarded as Angler-fishes modified in relation with a deep sea habit. The skin is bare and black in colour; the lure may be luminous; pelvic fins are absent. The bones are thin and light.

The Antennariidæ are strange-looking fishes occurring in tropical seas and rarely descending below the surface. They are sometimes called Frog-fishes because they creep along the rocks like Frogs or Toads, the pectoral fins being geniculated or bent after the manner of a knee-joint. *Chaunax pictus* (896), a reddish deep-sea fish, and *Antennarius histrio* (895) are shown. The species of *Antennarius* are numerous, and most of them occur in association with living corals, among which they lie effectively concealed by reason of the similarity between the colour of their skin and that of the coral. Some species (e. g. *Antennarius marmoratus*) occur in mid-ocean among the Gulf-weed (*Sargassum*).

In the Malthidæ the mouth is smaller than in most of the Lophiiform fishes and opens downward rather than upward. The

pectoral fin is strongly geniculated. The gill-opening is above the pectoral fin, instead of below or behind. There is no conspicuous lure; if present it is lodged in a depression below the snout and serves presumably as a tactile organ. The skin is provided with small tubercles or spines or bony warts. Most Malthid fishes are found in deep seas of the tropical regions, although the Bat-fish itself, *Malthe vespertilio*, 897, is a shallow-water form. It occurs abundantly in the West Indies. When on the ground it stands upon its pectoral and pelvic fins and resembles a Toad in general attitude. The skeleton of the Bat-fish (898) shows the remarkable elongation of the basal bones of the pectoral fins. *Halieutæa* (899) is allied to the Bat-fish, but the outline of the head is more circular, and there are also differences in the skeleton. Bat-fish.

BALISTIFORMES (File-fishes and Sun-fishes).

The suborder Balistiformes, or Plectognathi, includes aberrant fishes, such as the File-fishes, Trunk-fishes, Globe-fishes, and Sun-fishes. The jaws are short, the maxillary and premaxillary bones are often firmly united, and the teeth may be confluent into a beak. The bones of the gill-cover are reduced and the gill-opening is small. The vertebræ are comparatively few and there are no ribs. The flesh of most of these fishes is poisonous, and if eaten produces a disease of the nervous system known as "Ciguatera."

In the first family, the Triacanthidæ, the teeth remain separate; there is a spinous dorsal fin with one large and one or more smaller spines, and the pelvic fins have each the form of a strong spine, whence the name Triacanthidæ or three-spined fishes. They are fishes of the Indian and Pacific Oceans. Two species of *Triacanthus* (900 and 902) are exhibited, also a skeleton (901). A cast of *Halimochirurgus* from the Manaar Gulf, Ceylon, is shown in the series of Deep-sea Fishes (Cabinet-case 44, specimen 977). It is a deep-sea genus of the family, remarkable for its long, tube-like snout.

The Triodontidæ have the premaxillary bones confluent with the maxillaries, and the teeth are fused to form a beak. The upper

beak is divided by a median suture, whereas the lower is undivided, whence the name Triodont or three-toothed fishes. There is no spinous dorsal fin, and there are no pelvic fins. The abdomen has a dilatable sac. The body is covered with small spiny laminæ of bone. There is a single species, *Triodon bursarius*, 903, of the Indian Ocean.

File-fish. In the File-fishes (family Balistidæ) the teeth remain separate and have the form of incisors. There is a spinous dorsal fin; the pelvic fins are absent, or they take the form of a single short spine

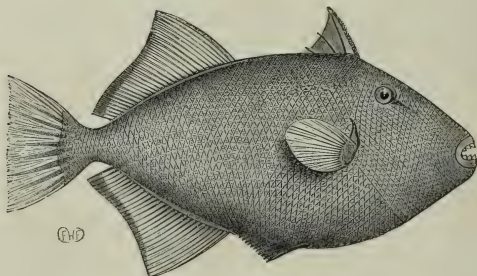


FIG. 93.—File-fish, *Balistes vidua*.

at the end of the long pelvis (see skeleton 912). The principal genera are *Balistes* (File-fishes or Trigger-fishes, fig. 93), *Monacanthus* and *Aluterus*. They are all inhabitants of tropical and temperate seas. The largest species of the genus *Balistes* grow to three feet. The body is protected by closely-fitting, hard, rhomboidal scales. The teeth are powerful and enable the animal to break off pieces of coral, etc., on which it feeds, and to bore into or chip the edges of shells of molluscs; the Pearl Oyster is particularly liable to attack (see the shells 920). One species of *Balistes* (*B. capriscus*, 911) is occasionally caught in British seas; the exhibited specimen was obtained on the Cornish coast. Eleven other species of *Balistes* are exhibited (907–910 and 913–919) which serve to show the wide range of colouring and marking observable in the genus. *Erythrodon* (921) is a subgenus of *Balistes* distinguished by the possession of red teeth. *Monacanthus*

does not have large bony plates in the skin, but very small scales or spines of uniform size; five species are represented, also a skeleton (922-927).

The Ostraciontidae, commonly called Trunk-fishes or Coffer-fishes (fig. 94), are tropical fishes living near the bottom in shallow water. The body is encased in a carapace formed of large bony plates, mostly hexagonal in shape. There is no spinous dorsal fin, and the pelvic fins are wanting. The chief genera are *Ostracion* and *Aracana*. Some species of the former have strong, sharp spines (e. g. *Ostracion cornutus*, 932), a pair pointing forward in front of the eyes and a pair pointing backward beneath the tail.

Trunk-
fish.

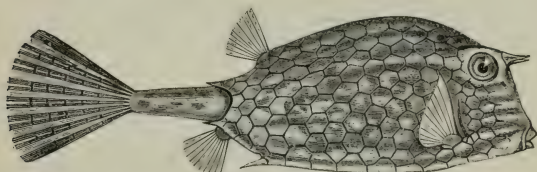


FIG. 94.—Coffer-fish, *Ostracion quadricornis*.

Six species of *Ostracion* are shown (929-934). *Aracana* differs from *Ostracion* in that the bony carapace is not closed behind the anal fin; three species are shown (935-937).

In the Tetodontidae the teeth are coalescent, forming upper and lower beaks. The beaks are divided by a median suture, so that there appear to be four large teeth, whence the name 'Tetrodont' (see skull 942). The skin is either smooth or with movable spines, rarely with bony plates. There is no spinous dorsal fin, and pelvic fins are wanting. The Tetrodont fishes can inflate their belly with air, whence they are commonly termed 'Puffers' or 'Globe-fishes.' When thus inflated they float helplessly at the surface of the water, belly upwards. The Tetrodont fishes occur in all tropical and warm seas; a few species are found in fresh water. Thirteen species of *Tetrodon* are shown (941, 943-947, 949-955) and a skeleton of *Tetrodon stellatus* (948).

Globe-
fish.

In the Diodontidae, as in the preceding family, the teeth are coalescent, forming beaks. The upper and lower beaks have no

Porcu-
pine-fish.

median suture, however, and appear as two great teeth, whence the name 'Diodont' (see jaws 956). There is no spinous dorsal fin, nor pelvic fins. The body is inflatable (fig. 95); there are movable bony spines in the skin, and in the long-spined species the spines stand out from the skin when the belly is inflated with air, although otherwise they slope backward. This capacity of erection of the spines has gained for the Diodont fishes the name of

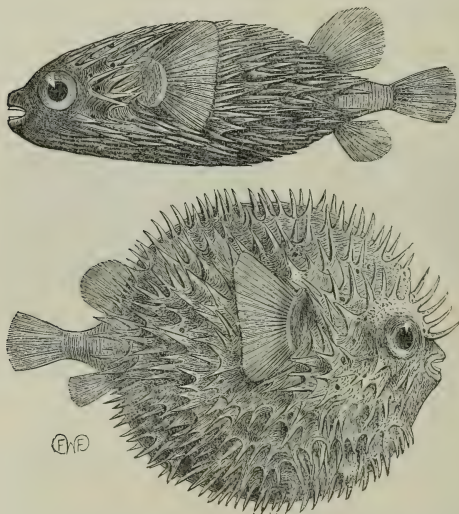


FIG. 95.—Porcupine-fish, *Diodon maculatus*; as swimming and when inflated.

'Porcupine-fishes.' Two specimens of the common Porcupine-fish, *Diodon hystrix*, are shown (958–959). the upper specimen in a state of inflation, the lower in the condition in which the fish swims about. Several other species are shown (961–966). The Diodontidæ are confined to tropical seas.

Sun-fish. In the Sun-fishes (family Molidae) the teeth are coalescent, forming beaks; these have no median suture. The swim-bladder is absent and the body is non-inflatable. The body is short and

has high dorsal and anal fins. There is no true tail, but the dorsal and anal fins are confluent around the truncated hind end of the body. There is no spinous dorsal fin, and pelvic fins are wanting. The Sun-fishes are of wide distribution, and grow to a great size. A large specimen of the Rough Sun-fish, *Orthogoriscus mola*, obtained from Australia, hangs from the middle of the roof at the northern end of the Gallery. A somewhat smaller specimen, caught off Dungeness, hangs from the rail opposite Wall-case 8. The small specimen (967) shown in Wall-case 20 was also caught on the English coast. The Sun-fish is of particular interest, because, although recently the young larvæ or Leptocephali of the Common Eel have been caught by nets in the Atlantic Ocean, our earlier knowledge of them was based mainly upon specimens found in the stomachs of Sun-fishes caught on the Italian coast. The



FIG. 96.—Oblong Sun-fish, *Ranzania truncata*.

Oblong Sun-fish, *Ranzania truncata*, 968 (see fig. 96, and compare with fig. 3, p. 11), differs from the Rough Sun-fish not only in shape, but in possessing a smooth skin with hexagonal plates, whereas the Rough Sun-fish has a rough, minutely granulated skin.

Classification of Fishes adopted in the Fish Gallery.

CLASS PISCES.

Subclass I. **ELASMOBRANCHII.**

Order 1. PROSELACHII.

Order 2. ACANTHODIDES.

Order 3. SELACHII.

Suborder 1. NOTIDANI.

Suborder 2. SQUALI.

Suborder 3. RAI.

Order 4. PLEURACANTHODES (= ICHTHYOTOMI).

Subclass II. **HOLOCEPHALI.**Subclass III. **OSTRACODERMI.**

Order 1. HETEROSTRACI.

Order 2. OSTEOSTRACI.

Order 3. PTERICHTHYOMORPHI (= ANTIARCHA).

Subclass IV. **DIPNOI.**

Order 1. CTENODIPTERINI.

Order 2. MONOPNEUMONES.

Order 3. DIPNEUMONES.

Order 4. COCCOSTEOMORPHI (= ARTHRODIRA).

Subclass V. **TELEOSTOMI.**

Order 1. STYLOPTERYGII (= CROSSOPTERYGII, auct.).

Suborder 1. TARRASIOIDES (= HAPLISTIA).

Suborder 2. HOLOPTYCHIOIDES (= RHIPIDISTIA).

Suborder 3. CÆLACANTHOIDES (= ACTINISTIA).

Suborder 4. POLYPTEROIDES (= CLADISTIA).

Order 2. ASTYLOPTERYGII.

Suborder 1. STURIONIFORMES (= CHONDROSTEI).

Suborder 2. AMIIFORMES (= PROTOSPONDYLI).

Suborder 3. LEPIDOSTEIFORMES (= ÆTHEOSPONDYLI).

These are often spoken of
as "Ganoid Fishes."

Order 3. NEICHTHYES (= TELEOSTEI).

Grade A. **Physostomi.**

Suborder 1. SALMONI-CLUPEIFORMES (= ISOSPONDYLI).

Suborder 2. CYPRINI-SILURIFORMES (= OSTARIOPHYSI).

Suborder 3. SYMBRANCHIFORMES.

Suborder 4. ANGUILLIFORMES (= APODES).

Suborder 5. ESOCIFORMES (= HAPLOMI).

Grade B. **Physoclisti.**

Suborder 6. HALOSAURIFORMES (= HETEROMI).

Suborder 7. GASTROSTEIFORMES (= CATOSTEOMI).

Division 1. *Selenichthyes*.Division 2. *Hemibranchii*.Division 3. *Lophobranchii*.Division 4. *Hypostomides*.

Suborder 8. MUGILIFORMES (= PERCESOCES).

Suborder 9. GADIFORMES (= ANACANTHINI, in part).

Suborder 10. ACANTHOPTERYGII.

Division 1. *Perciformes*.Division 2. *Scombriformes*.Division 3. *Zeorhombiformes*.Division 4. *Kurtiformes*.Division 5. *Gobiiformes*.Division 6. *Echeneiformes* (= *Discocephali*).Division 7. *Trigliformes* (= *Scleroparei*).Division 8. *Blenniiformes* (= *Jugulares*).Division 9. *Trachypteriformes* (= *Tæniosomi*).Division 10. *Mastacembeliformes* (= *Opisthomi*).

Suborder 11. LOPHIIFORMES (= PEDICULATI).

Suborder 12. BALISTIFORMES (= PLECTOGNATHI).

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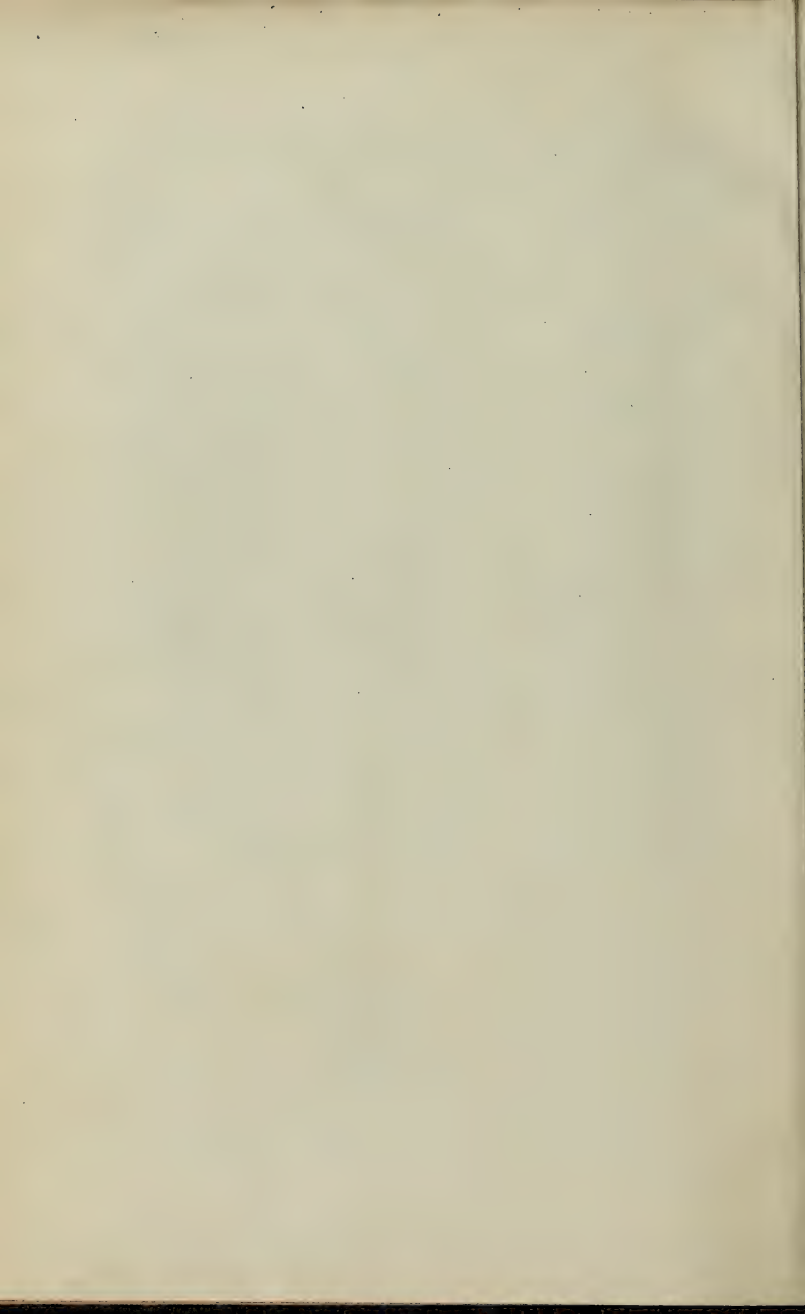
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